EFFECTIVENESS OF COGNITIVE ORIENTATION TO OCCUPATIONAL PERFORMANCE (CO-OP) TO IMPROVE HANDWRITING PERFORMANCE IN CHILDREN WITH DEVELOPMENTAL COORDINATION DISORDER

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CERTIFICATE

This is to certify that the research work entitled **EFFECTIVENESS OF COGNITIVE ORIENTATION TO OCCUPATIONAL PERFORMANCE (CO-OP) TO IMPROVE HANDWRITING PERFORMANCE IN CHILDREN WITH DEVELOPMENTAL COORDINATION DISORDER** was carried out by **Reg. No. 411613001**, KMCH College of Occupational Therapy, towards partial fulfilment of the requirements of Master of Occupational Therapy (Advanced OT in paediatrics) of the Tamil Nadu Dr. M.G.R. Medical University, Chennai.

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ABSTRACT

Background: Handwriting competence is frequently affected, consequently affecting legibility of written output and thus affecting academic achievement. Cognitive Orientation to (daily) Occupational Performance (CO-OP) is an intervention that facilitates motor skill acquisition in children with Developmental Coordination Disorder (DCD*).*

Aim: Therefore the aim was to determine the effectiveness of Cognitive Orientation to Occupational Performance (CO-OP) to improve handwriting performance in children with Developmental Coordination Disorder (DCD).

Methodology: A quasi-experimental study design was adopted. Thirty four children with DCD with handwriting difficulties were screened and assigned into experimental and control group. DCD Questionnaire was used as screening tool, COPM, PQRS, Beery Buktenica developmental scale for visual motor integration, visual perception and motor coordination and ETCH – M were used as the outcome measures. The children in the experimental group were given CO-OP intervention, whereas the control group were given handwriting practice as homework .The duration of intervention was 45 minutes once a week. They were asked to practice the strategies at classroom as well at home during the rest of the days of the week.

Results: Children in the CO-OP group showed a significant difference in COPM from baseline to week 12 in performance and satisfaction ,PQRS score ($p<0.05$), indicating improvement in performance. Additional skills of VMI, VP and MC ($p<0.05$) ,showed a significant increase in the CO-OP group compared to control group . There was a significant improvement in word, letter and numeral legibility ($p<0.05$) at post intervention in comparison to the control group.

Conclusion: This finding proves that Cognitive Orientation to Occupational Performance approach improves handwriting performance in children with Developmental Coordination Disorder.

Keywords: Handwriting, Cognitive Orientation to Occupational Performance, Developmental Coordination Disorder.

INTRODUCTION

"Handwriting is one of the most important occupations during childhood which is essential for the participation of the child in the classroom environment. Handwriting is the primary form of written expression for the young and elementary school children"[1].

Competency in handwriting is considered as an important skill that the children have to acquire during their initial years at school[2,3]. Thirty to sixty percent of the activities of a school day constitutes fine motor activities, among which handwriting is the most predominant task[4,5]. Being a foundational skill, if the child fails to achieve this, it may have implications for the child's future and academic performance[6].

Occupational therapists are concerned with the production of non-proficient handwriting in children. Feder & Majnemer (2007) in their study found that treatment may differ according to the cause of such handwriting, among which poor performance in perceptual and motor skills are one of the factors[2,3].

Handwriting requires a majority of fine motor skills along with the combination of cognitive and visual perceptual abilities. Daftari and Jaywant (2015) in their study found that difficulty in handwriting is an anticipated factor in children diagnosed with Developmental Coordination Disorder (DCD) and such children are found to have dystrophic handwriting[7]. DSM 5 criteria characterises dystrophic handwriting as having distortions in overall shape of the letters, distortions in the relative size of the letters, irregular spacing between letters and crowding of words[8].

DCD or dyspraxia is a movement disorder in which the children experience difficulties in the acquisition and execution of coordinated and controlled movements. Due to this, children with DCD have marked impairment in activities of daily living and academic achievements. The children with DCD have difficulties which are manifested as clumsiness, slowness and inaccuracy in the performance of motor skills.

Prevalence of DCD in India was found in a normal school going population in a study done by Komal K B and Parmar Sanjay (2014) and it was concluded that among 5-15 years of children, 65 were found to have DCD when screened with Developmental Coordination Disorder Questionnaire (DCDQ). The results showed that girls (23.23%) were affected more than boys (19.31%)[8]. Rubin & Henderson (1982) estimated that handwriting problems in the normal school going children, ranges from 5% to 25%[9]. This incidence is much greater in children with Developmental Coordination Disorder or Learning Disability (disorder of written expression). According to American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders 5th ed, 2013, poor handwriting is a diagnostic indicator of the above conditions[10].

Case smith and Feder (2002) in their study found that major contributor towards the intervention for handwriting problems in children with DCD is made by Occupational Therapy[6]. The need is increasing especially for school-based occupational therapists. Chandler (1994) and Clark Wentz (11997) in their study found that usually the children are referred for assessment and treatment for difficulty in handwriting[11,12]. An OT assesses fine-motor skills, visual perception, visual motor integration, motor control, coordination and postural skills in the children to find out in-coordination which is the root cause of handwriting difficulty in children with DCD.

Historically theories have suggested that there is a direct relationship between the underlying process and functional performance and therefore intervention was focused on improving the underlying processing deficits. However, recent studies have suggested that direct focus on skill acquisition has positive effects on children with DCD. Among such interventions which follow a "top-down" approach, Cognitive Orientation to Occupational Performance (CO-OP) approach has shown promising effects[13,14,15,16,17].

Polatajko and Mandich in 2004 developed Cognitive Orientation to Occupational Performance (CO-OP), which uses cognitive based strategies to improve performances of specific tasks based on child chosen goals[17]. CO-OP uses problem solving techniques to facilitate motor skill acquisition. The therapist facilitates the child to generate his/her problems in their performance areas. This involves a combination

of strategies such as Global Strategies and Domain Specific Strategies (DSS). Global strategies involve Goal, Plan, Do, Check (GDPC) which can be easily learnt and applied by the child. The Domain Specific strategies (DSS) involves seven strategies which are task specification, verbal mnemonic, body position, feeling the movement, attention to doing, verbal guidance, verbal self-guidance, verbal role script.

Banks and Rojer's study (2008) aimed to elucidate the specific strategies used by children with DCD while addressing handwriting goals. **Discussion, not practice, was the predominant tool employed to improve performance**[14]. Significantly, the children most often used strategies that increased their awareness and understanding of task requirements. But the study included only 4 boys. Very small sample size, restriction to one gender and lack of focus on transfer of strategy use between goals became a major limitation for the study[14].

NEED OF THE STUDY:

Study done in western country by Ward A and Roger S in 2004 investigated the utility of CO-OP with children aged 5-7 and have proved its effectiveness upon child set goals upon COPM in which handwriting was a need for both the children, but had a very small sample size[13].

An Indian study by Daftari and Jaywant (2015)**,** on typically developing children with handwriting difficulties, showed that the use of CO-OP research in occupational therapy intervention, improves handwriting performance skills[7].

In India apart from prevalence studies no other interventional studies have been done upon DCD. In the previous studies upon DCD which have been published in international journals, such as Mandich et al (2001) when given COPM, most of the children in the younger age group and the parents have specified handwriting as one of the goals as school performance ranks among the most essential tasks[16].

To address the limitations of most of the studies there is need for research having a significant sample size of children with DCD, to overcome their motor in-coordination with a cognitive approach such as CO-OP to improve handwriting. This asserts the need of the study.

RESEARCH QUESTION

Therefore the research question is highlighted as follows:

Will Cognitive Orientation to Occupational Performance (CO-OP) approach improve handwriting in children with Developmental Coordination Disorder (DCD)?

AIM AND OBJECTIVES

AIM:

To determine the effectiveness of CO-OP approach to improve handwriting in children with Developmental Coordination Disorder (DCD).

OBJECTIVES:

1. To evaluate the effectiveness of CO-OP approach on DCD.
2. To analyze the improvement in handwriting towards end of the intervention program
3. To find out the performance and satisfaction of children with DCD following CO-OP intervention for handwriting improvement.

OPERATIONAL DEFINITIONS

Developmental Coordination Disorder:

A condition in which children often experience fine and gross motor difficulties, which affect their participation in classroom and other Activities of Daily Living (ADL) (Dewey and Wilson 2001).

Cognitive Orientation to Occupational Performance:

A direct intervention for children with Developmental Coordination Disorder (DCD) is a client centered approach that focuses on skill acquisition, cognitive strategy development, global strategies of Goal, Plan, Do and Check and discovery of domain-specific strategies for probem solving and generalization and transfer where the child can use the skills and strategies for other daily tasks. (Polatajko, Mandich, Missuina 2001; Sangster, Beninger, Polatajko, & Mandich, 2005).

Handwriting:

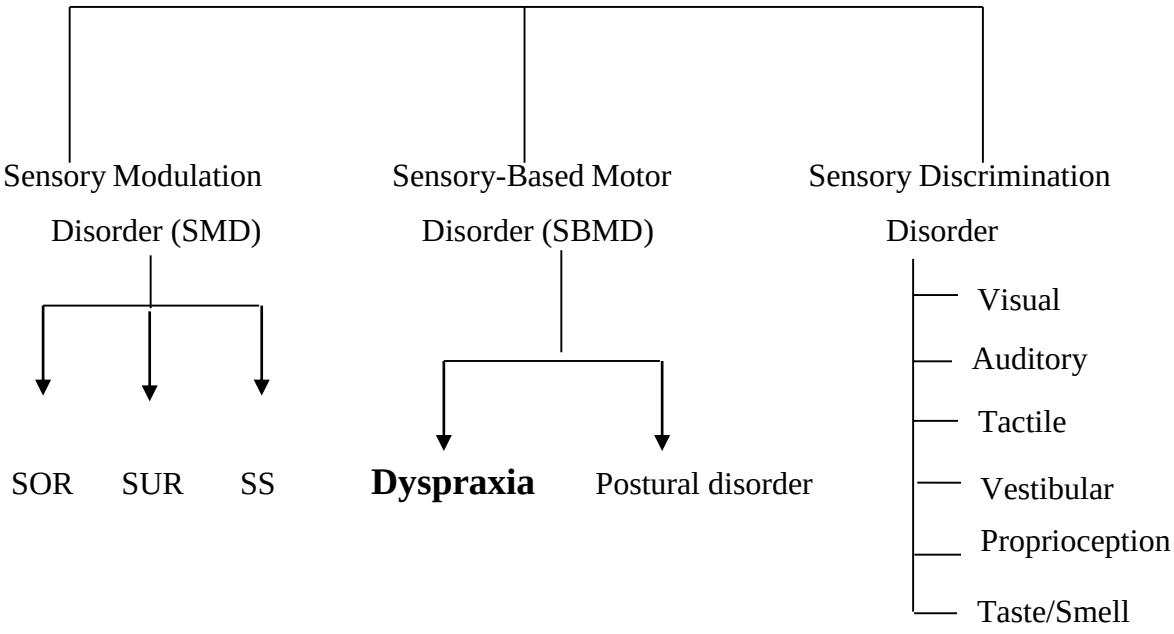
A complex skill, requiring the maturation and integration of cognitive, visual perceptual and fine motor skills. (Chu S. Occupational therapy for children with handwriting difficulties: A framework for evaluation and treatment. *British Journal of Occupation Therapy.* 1997; 60:12 514-520).

RELATED LITERATURE

Definition: Children with developmental coordination disorder, have difficulty in the activities requiring coordination and movement. Therefore it affects their fine and/or gross motor coordination. Activities such as self care, typing, writing riding a bike and playing are of utmost difficulty for the children with DCD as their coordination is affected.

Nosology of Sensory Processing Disorder[18]**:** Dyspraxia is one of the Sensory processing disorders. According to Miller (2007) the new concept of Sensory Processing Disorder is categorised as Sensory Modulation Disorder (SMD), Sensory Based Motor Disorder and Sensory Discrimination disorder. Sensory modulation disorder is again classified into Sensory Under Responsivity (SUR), Sensory Over Responsivity (SUR), and Sensory Seeking (SS). Sensory based motor disorder as **Dyspraxia or Developmental Coordination Disorder (DCD)** and postural disorder; Sensory discrimination disorder categorised into visual, auditory, tactile, vestibular, proprioception and taste/smell.

SENSORY PROCESSING DISORDER (SPD)



SOR=Sensory Over-Responsivity

SUR=sensory UnderResponsivity

SS=Sensory Seeker/Craver

The neurophysiology involves the information which are received from the senses, followed by sensory integration. The central processing which occurs following that involes decision making and ordering of priorities. Therefore the child involuntarily does motor planning before executing it.

Development of handwriting in typically developing children:

Development of Prewriting and Handwriting in typically developing young children is given by Bayley scales on infant development as follows (Relationship between visual motor and handwriting skills of children in kindergarden. *Americal journal of occupational therapy, 48, 982-988).*

PERFORMANCE TASK	AGE LEVEL
Scribbles on paper	10-12 months
Imitates horizontal, vertical and circular marks on paper	2 years
Copies a vertical line, horizontal line and circle	3 years
Copies a cross, right oblique line, square, left diagonal line, left oblique cross, some letters and numerals and may be able to write own name	4-5 years
Copies a triangle, prints own name, copies most lower- and upper-case letters	5-6 years

In case of children with DCD, there is disruption in the way messages from the brain are transmitted to the body. This affects the child's ability to perform movements in a smooth and coordinated way. Thus DCD is also referred to as childhood dyspraxia, Specific developmental disorders of motor function and Clumsy Child Syndrome.

Children with DCD, exhibit lateness in achieving developmental milestones such as sitting and walking. Delayed development is also noted in speech milestones. Activities requiring physical coordination such as running, hopping, jumping and playing catch and throw with a all are of particular difficulty for the child. Academic activities are also affected due to decreased attention span, increased distractibility, difficulties copying from blackboard, difficulty following more than 1 instruction at a time. Activities of play such as solving a jigsaw puzzle, shape sorting games, constructional toys such as lego blocks are also difficult for the child. Other activities such as art work shows particular immaturity and incoordination. Child also has difficulty understanding positional concepts such as in/ out/ on/ below/ behind/ in front/ forward/ backward/ reversal etc.

Handwriting competency is frequently affected, consequently affecting legibility and/or speed of written output and thus ultimately affecting academic achievement. The impact is distinguished from Specific Learning Disability (SLD) by the emphasis on the motoric component of written output skills.

Interventions for improving handwriting performance in DCD:

To address handwriting difficulties in children with DCD, researches have come up with two types of intervention: process-oriented intervention and task-oriented intervention. Process-oriented approach addresses all the underlying deficits which causes motor in-coordination such as sensory processing difficulties and therefore focuses on Sensory Integration Therapy as the mode of intervention.

Recent research has proved that task-oriented intervention is much more beneficial and this includes Neuro-motor task training, and use of cognitive strategies such as CO-OP. CO-OP is an approach which was developed especially for children with DCD.

Foundation of CO-OP[19]:

Cognitive Orientation to daily Occupational Performance (CO-OP) is an individualized, client-centred approach focused on strategy-based skill acquisition. CO-OP is essentially a cognitive approach to solving daily occupational performance

problems. In CO-OP, a global problem-solving strategy is used to frame the development of domain specific strategies that enable successful task performance and promote skill acquisition. CO-OP is a highly verbal approach in which cognitive strategies are mapped onto performance to facilitate and support performance.

Objectives:

CO-OP has three basic objectives:

***Skill acquisition**:* The child learns to perform the required or desired skills. In CO-OP, a client-centred approach is used to identify the skills to be learned. *The Canadian Occupational Performance Measure* (COPM) is used with the child to identify the three skills that he/she needs to, wants to, or is expected to do at school, home, or play that will be the focus of treatment. The COPM is a self-report measure that allows children to rate both their level of performance and satisfaction when carrying out tasks that they need to do on a regular basis.

***Cognitive strategy development**:* the child learns to use a global problem solving strategy to frame the discovery of domain specific strategies that will solve performance problems and thereby, improve performance and promote skill acquisition.

***Generalization and transfer**:* the child uses the newly acquired skills and strategies beyond the treatment session, in everyday life, and these skills and strategies serve as a foundation for learning related skills and strategies.

Prerequisites:

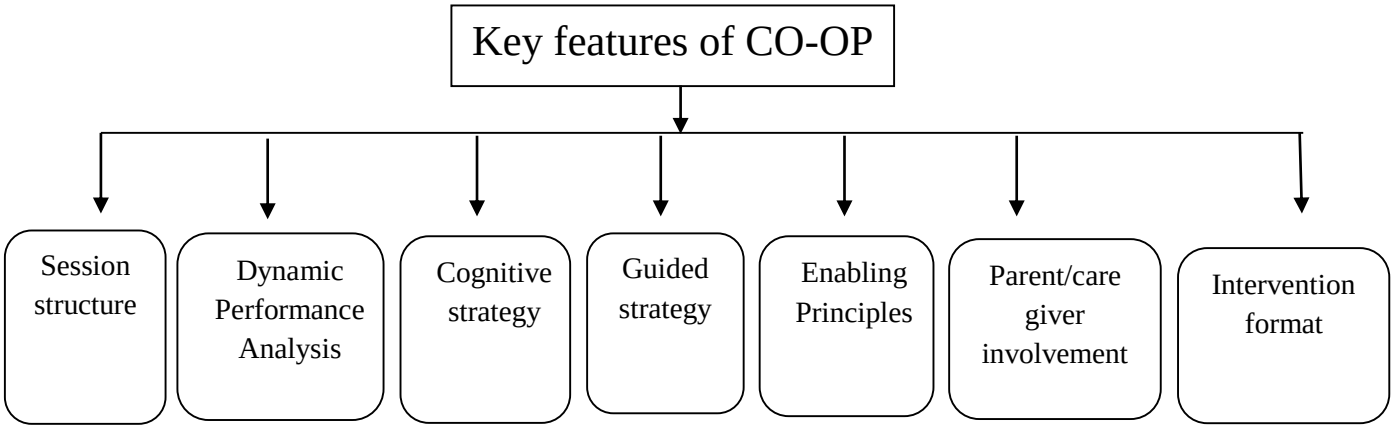
For the CO-OP approach to be successful, there are a number of prerequisites for all involved: the child, his/her parents and/or caregivers and the therapist. To benefit from the CO-OP approach, the child must: have sufficient cognitive and language ability to respond to the COPM; be able to identify three occupational goals;

- Be able to respond and attend to the therapist;
- Have the potential to perform the task; and
- Have the motivation to learn three skills.

The approach is most successful if the parents and/or caregivers are involved and committed to implementing the approach beyond the treatment arena. To be able to implement the CO-OP approach successfully, the therapist must already bring with him or her effective communication skills, experience with the management of children with disabilities in a child-centered framework, excellent skills in task analysis, and a commitment to working with parents. In addition, the therapist must become proficient in the CO-OP approach.

Key features of the co-op approach

There are six key features to the CO-OP approach: session structure, child-chosen goals, dynamic performance analysis, cognitive strategies, enabling principles and parent/caregiver involvement which are briefly explained below:



Key feature 1: Session Structure: In Cognitive Orientation to daily Occupational Performance (CO-OP) the therapy sessions are offered according to a structured format. CO-OP is usually delivered over **twelve, one-to-one sessions, each of approximately one hour in length**. Parents and/or caregivers are encouraged to observe as frequently as possible, in order to encourage generalization and transfer. The therapy process is divided into **five phases: Preparation, Assessment, Introduction, Acquisition and Consolidation.**

Child-Chosen Goals: CO-OP is a child-centred approach. The child's perspective is of central importance throughout, beginning with the process of goal setting and continuing throughout the intervention. Having children choose their own goals ensures

ecological relevance, which promotes motivation, transfer and generalization. A daily activity log is provided to the child in advance of the goal-setting session. The log helps children reflect upon the activities that they do each day. At the beginning of the assessment phase, the COPM is used to ensure that the goals that will be focused on during intervention are child-chosen.

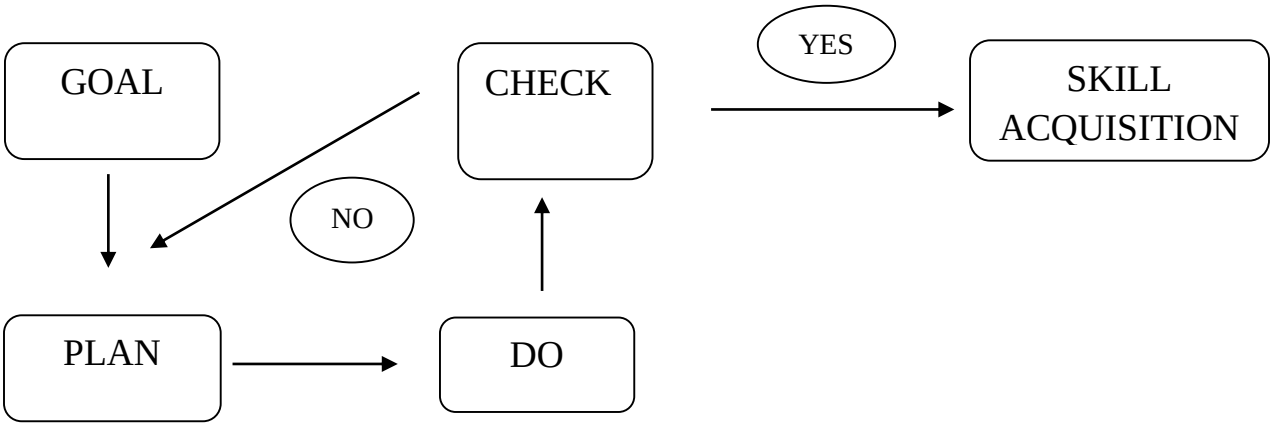
Key feature 2: Dynamic Performance Analysis (DPA): DPA was developed in concert with the CO-OP approach to allow for continuous evaluation of performance and to structure the problem solving process. The purpose of DPA is to solve performance problems by identifying where performance breaks down, identifying possible solutions and testing them out in a trial and error fashion. Dynamic performance analysis (DPA) is based on three assumptions regarding occupational performance: that *motivation* is a necessary prerequisite for successful performance; that an individual requires adequate *knowledge of a task* before he or she can successfully perform the task and that *occupational performance* is the result of the interaction of person, occupation, and environment.

Key feature 3: Cognitive Strategies: In CO-OP, two kinds of strategies are used: a global strategy and domain-specific strategies. A ***global strategy*** utilized in CO-OP is Goal-Plan-Do-Check. The global strategy provides a structure within which the therapist or child can talk through the problems encountered in task performance. When using the Goal- Plan-Do-Check framework, the child is taught to use the following line of self-talk:

GOAL: What do I want to do?
PLAN: How am I going to do it?
DO: Do it! (carry out the plan)
CHECK: How well did my plan work?

GOAL requires self-interrogation, the PLAN requires the child to self-monitor, the DO demands self-observation, and the CHECK fuels self-evaluation and self-reinforcement. Using this global framework, the child learns to talk him or herself through the task, and to develop metacognitive problem solving skills. The Goal-Plan-Do-Check strategy is a central feature of the CO-OP approach to treatment. It is taught

to the child during the second intervention session, and reinforced throughout subsequent therapy sessions. It not only provides a global problem solving strategy for the child, but also provides a vehicle for discovering domain specific strategies.



Domain Specific Strategies (DSS) are an array of specific cognitive strategies, which focus on facilitating or improving performance that are task, child, or situation specific. There are eight domain specific strategies used in CO-OP: body position, task specification/modification, feeling the movement, verbal motor mnemonic, verbal rote script, verbal instruction, verbal self-instruction, and attention to doing. The emphasis during intervention is on helping the child to see how he or she can set goals, plan actions, talk him or herself through doing, and check outcomes. In other words, the focus is on metacognitive problem solving processes.

Key feature 4: Guided Discovery: This is a process created for use of CO-OP to ensure that the children discover the strategies that will solve their performance problems by themselves. It is also possible to use strategies without using this process. It is an important learning concept. It involves Meichenbaum's scaffolding techniques and meditational techniques of Feurestein et al. Here the adult leads the child to discover answers to problems and it has been shown to be more effective than discovering learning where the child is asked to discover answers on his own.

Key feature 5: Enabling Principles of CO-OP: Enabling principles are an integral part of the CO-OP therapeutic approach and are used throughout the therapeutic intervention.

They are captured in 6 imperatives:

Make it fun

Promote Good strategy use

Frame It in Goal-Plan-Do-Check

One Thing at a Time

Work Toward Independence

Guided Discovery

Key feature 6: Parent/Caregiver Involvement: Parent involvement in the CO-OP approach is crucial to promote the child's ongoing skill acquisition, strategy use, and generalization and transfer of learning. The therapist can promote parental involvement by ensuring that parents learn about the salient features of CO-OP and the application of enabling principles. In this way the parent provides a critical link between the therapeutic setting and other environments. Use of the CO-OP approach, within a research paradigm, has provided evidence of the effectiveness of the approach with children with DCD. This approach presents an alternative for therapists interested in a direct approach to the treatment of performance problems in children with DCD.

Key feature 7: Intervention format: the first phase of preparation is the GOAL phase. The therapist meets the parents or significant others along with the child to establish child's chosen and the baseline level of performance. This initial contact with parents is necessary to provide them with a general orientation to the approach to ensure that all the perquisites are met, and to make it clear to the parent/caregiver the expectations for involvement.

The second phase of ACQUISITION involves PLAN and DO phase where the work of using strategies to acquire skills through task performance is accomplished. The final verification phase: CHECK consists of only one session in which the progress made is reviewed along with the strategies learnt by the child. The child is questioned about the various strategies that he learnt and about generalising and transferring of the learnt skills. COPM and PQRS are repeated to verify that the child chosen goals have been accomplished.

REVIEW OF LITERATURE

Effectiveness of CO-OP approach for DCD:

O'Dea and Connel (BJOT 2016) did a study and examined "**The performance difficulties, activity limitations and participation restrictions experienced by adolescents aged 16–19 years with developmental coordination disorder"**. The experience of disability was analysed for 40 individuals who completed the optional measure of activity and participation section, including the World Health Organization Disability Assessment Schedule II. Results revealed that adolescents experience cognitive rather than physical impairments evolving from executive functioning and social skills. These impact on participation restrictions in academic, vocational, recreation and family life areas. Adolescents required access to the specific health services of occupational therapy to improve their academic and vocational skills[20].

Engelsman, Blank, Kaay, Rianne, Brand, Polatajko and Wilson (Developmental medicine and child neurology, 2013) did a review study: The aim of this study was to review systematically evidence about the efficacy of motor interventions for children with developmental coordination disorder (DCD), and to quantify treatment effects using meta-analysis. The study included were all studies published between 1995 and 2011 that described a systematic review, (randomized) clinical trial, or crossover design about the effect of motor intervention in children with DCD. Twenty-six studies met the inclusion criteria for the review. Interventions were coded under four types: (1) task-oriented intervention, (2) traditional physical therapy and occupational therapy, (3) process-oriented therapies, and (4) chemical supplements. The results of the study include A comparison between classes of intervention showed strong effects for task-oriented intervention and physical and occupational therapies, whereas that for process-oriented intervention was weak. Comparison between treatment types showed that the effect size of the task-oriented approach such as CO-OP was significantly higher than the process-oriented intervention and comparison. However, approaches from a task-oriented perspective yield stronger effects. Process-oriented approaches are not recommended for improving motor performance in DCD, whereas the evidence for chemical supplements for children with DCD is currently insufficient for a recommendation[9].

Donna Y K Chan in her study **The application of Cognitive Orientation To daily Occupational Performance (CO-OP) in children with Developmental Coordination Disorder (DCD) in Hong Kong: a Pilot study",** (2007) aimed to investigate the effectiveness of co-op and to improve motor, cognitive and functional performance after treatment in children with DCD in a single-group pilot trial. Six children with DCD were recruited consecutively by convenient sampling at a single time occasion. A treatment programme based on the co-op, which consisted of seven weekly sessions, was provided for all children in a closed group format. Motor, cognitive and functional performances were evaluated pre-/post-treatment. The study resulted in significant differences after treatment were found in activity performance in motor planning, motor process, and daily life within the group. The conclusion of the study indicated that the co-op focused in the cognitive domain helped to improve problem-solving skills and organization of daily chores in everyday life. This pilot study demonstrated the effectiveness of this new approach in clinical application and provided a good piece of preliminary evidence in the local context[21].

Poulsen, A. A., Ziviani, J. M., Cuskelly, M., & Smith, R. American Journal of Occupational Therapy (2007) in their study, Boys with developmental coordination disorder, aimed to investigate the mediational role of team sports and other leisure occupations for boys ages 10 to 13 years in the relationship between physical coordination ability and perceptions of loneliness. The study included sixty boys with developmental coordination disorder (DCD) and 113 comparison boys without DCD completed a self-report measure of loneliness. Parents recorded information on leisure involvement over 7 days. The results of the study included boys with DCD recorded significantly higher loneliness and lower participation rates in all group physical activities, whether structured (e.g., team sports) or unstructured (e.g., informal outdoor play) than boys without DCD. An inverse relationship between physical coordination ability and loneliness was mediated by participation in team sports. No other leisure pursuits were found to be significant mediators. Childhood physical coordination difficulties were significantly associated with loneliness. The study concluded that participation in team sports acted as one potential mechanism mediating the inverse relationship between physical coordination ability and loneliness in boys. Occupational

therapists can act as advocates to support boys with DCD who choose to participate in team sports. Further investigations are recommended to determine aspects of team sports environments that promote an optimal fit among child, activity, and environment and team sports participation[22].

Claire A. Sangster, Claire Beninger, Helene J. Polatajko, Angela Mandich (CJOT, 2005) did a study, "**Cognitive strategy generation in children with developmental coordination disorder: A pilot study"** that investigated the use of cognitive strategies in children with DCD to determine whether cognitive strategy use is improved by CO-OP. Observations of video-recorded sessions of 18 school-aged children were scored for frequency and type of cognitive strategies used. The results of the study included differences within and between groups revealed changes in the types and frequency of cognitive strategies. The results of the present study support the use of a cognitively-based approach such as CO-OP in assisting children with DCD in developing cognitive strategies when solving occupational performance problems. However, further research using a larger sample is necessary to fully explore the impact of CO-OP on the strategy use of children with DCD[23].

Marie-Laure Kaiser (Scandinavian Journal of Occupational Therapy, 2013) did a study, "**Children with Developmental Coordination Disorder: The Effects of Combined Intervention on Motor Coordination, occupational performance and Quality of Life: A pilot study"**, which included a group of 33 boys and 12 girls (5.4 to 10.7 years) with developmental coordination disorder (DCD) aimed to analyze (1) the effects of a combined approach on motor coordination, occupational performance, and quality of life and (2) the relationship between motor coordination and occupational performance. Movement ABC (M-ABC) and Canadian Occupational Performance Measure (COPM) were administered at the beginning of Occupational Therapy (T1) and after 3 (T2) and 9 months (T3). Results showed significant improvements in the COPM and at in the M-ABC. No relationship between the results of M-ABC and those of COPM was found[24].

Effectiveness of CO-OP approach to improve handwriting performance for children with DCD:

Banks,R. Rodger,S. and Polatajko,H (OTJR: Occcupation, Participation and Health 2008), aimed to elucidate the specific strategies used by children with DCD while addressing **handwriting** goals. In this descriptive study, 4 boys aged 6 to 11 years who had DCD were videotaped while engaging in 10 hour long CO-OP treatment sessions over 5 consecutive weeks. Motor skill deficits in children with DCD are addressed through CO-OP intervention. There is need for preliminary research which has recently begun to prove the significance of cognitive strategies which are the basis of CO-OP approach. Common trends were observed within each handwriting sub-goal, but the children did not apply identical domain-specific strategies to improve their handwriting. Furthermore, despite using the same types of strategies, each child developed his own unique strategies (Table 2). The most significant feature of the data is the pre-eminence of Task Specification/Modification strategies. Task Specification/Modification encompassed strategies that addressed task specifics (e.g., start writing from the left) and also those that involved modifying components of the task (e.g., try using a sharper pencil). The children's recurrent and consistent use of these strategies indicates that they struggled to understand the requirements of handwriting activities. The study concluded that "***Discussion not practice was the predominant tool*** *employed to improve performance. Significantly the children most often used strategies that increased their awareness and understanding of task requirements"*. It was observed that children used strategies that heightened their awareness and understanding of task requirements more often. The study supported the fact that DCD represents the physical and motor manifestation of a learning problem[14].

Ward A, Roger S, (BJOT) in 2004 did a study in the **"Application of Cognitive Orientation to Occupational Performance with children 5-7 years with Developmental Coordination Disorder"**. The study aimed to evaluate the effectiveness of CO-OP approach in 5-7 years old children. The two boys involved in this study (Dan and Sean) were both 6 years old and in their first year of formal schooling. They were referred for occupational therapy by their parents on their teachers' advice because of motor difficulties having an impact on their **handwriting**,

physical education and playground and literacy skills. Their mothers shared these concerns, particularly each child's difficulty with **homework**. After conducting a pre-test the children were given 10 treatment sessions of intervention upon each of their respective child chosen goals as identified by COPM. PQRS (Performance Quality Rating Scale) was used to rate the sessions which were twice a week. After 10 treatment sessions, working on three goals each the child had identified using COPM. Sessions were twice a week. This study proved that CO-OP could be used and very effective in 5 to 7 yr old children. These two case studies demonstrated that younger children with DCD were able to use the CO-OP framework to enhance their performance of motor-based goals. Their ability to learn and apply the global framework to a goal was evident in their ability to engage with the therapist in plan development and to use checking strategies. These two young boys used a wide range of Domain Specific Strategies(DSS) during the intervention for each goal, with Task Specification, Body Position, Verbal Rote Script and Mnemonics being among the most frequently used DSSs. **Handwriting** was a goal set by both the subjects at this younger age and the children perception of their performance and satisfaction with their performance reportedly improved[13].

Jongmans M J, Linthrost B E, Englesman S did a study in 2003, **"Use of task oriented self instruction method to support children in primary school with poor handwriting quality and speed".** The study used task-oriented intervention using a self instruction method in a group format with children in special education classes. The control group had regular writing instruction while the experimental group used task-oriented self-instruction method for two 30 minute sessions for a week for a period of six months. Children with poor handwriting who received intervention showed a greater improvement in the quality of their handwriting compared to their peers with poor handwriting who did not receive intervention. Seventy-two percent of children with dysgraphic handwriting who received intervention were not classified as "dysgraphic" on post test. It was also found that children who had "normal" handwriting who did not receive intervention actually deteriorated at post test, six months later. The authors concluded that self-instruction improved handwriting quality

of children with poor handwriting and "protected" those with "normal" handwriting from deteriorating over the six months of the study[28].

Missiuna, Mandich, Polatajko, & Malloy-Miller, 2001; Mandich, Polatajko, Macnab, & Miller (Human Movement Science, 2001) did a study **"Cognitive treatment for children with Developmental Coordination Disorder: A pilot trial"**. In their study they compared the performance of 10 children with DCD aged 7 to 12 years who were exposed to the CO-OP approach to the performance of 10 children with DCD who received a comtemporary treatment approach (CTA). Contemporary treatment included a variety of approaches, including multisensory intervention. Although this study did not the examine the effectiveness of handwriting, 16 of the 20 children involved in the study chose **printing or cursive writing** as one of their treatment goals**.** The cognitive orientation to daily occupational performance (CO-OP) approach combines Meichenbaum's (1977) verbal guidance and self-instructional training with a global problem solving strategy. Compared to the control group, the children in the CO-OP interventional group rated greater scores in their performance and satisfaction of their treatment goals. Even though the study did not measure the effectiveness of handwriting, Polatajko and colleagues concluded that further research is essential in the remediation of handwriting difficulties faced by children with DCD[15].

Bernie C and Roger S (Physical Occupational Therapy Pediatrics, 2001) did a study where they used cognitive strategy in school aged children with developmental coordination disorder. Systemic observation of videotaped intervention sessions were used to identify the frequency and type of strategies that four children with DCD used during the CO-OP intervention, who had **handwriting** as one of their goals. Verbal based strategy was the difference found between younger and older children when compared. Cognitive strategy used may be more related to the child and intervention goal to age[26].

Martini R, Polatajko H J, (Occupation Therapy journal of research, 1998) did a study of using **"Verbal guidance as a treatment approach for children with Developmental Coordination Disorder"**. The study examined children in the age group of 5 – 12 years group. All the children had motor coordination difficulty and had only average intelligence. Half of the children included in the study had **handwriting**

as their goal to be worked on. Cognitive Occupational Performance Measure (COPM) was used to rate the performance and satisfaction scores post the intervention session. The results of the study indicated that all the children had learnt the CO-OP approach successfully and all their scores of performance and satisfaction of the task increased post-intervention[27].

Daftari and Jaywant (2015) did a study **"To study the efficacy of Cognitive orientation to Occupational Performance in children with handwriting difficulties"** to prove the effectiveness of CO-OP approach to improve handwriting performance. In their research showed that the use of CO-OP research in occupational therapy intervention, improves handwriting performance skills. Children referred to Outpatient Occupational therapy for complaints of handwriting were taken for the study. 8 children between 7 to 9 years with I.Q below 90 were selected for the study. ETCH tests were used as outcome measure. 10 individual CO-OP sessions each session 1 hour for 2.5 weeks. "Plan-do-check" method of CO-OP was used to improve handwriting in these children. Although the CO-OP approach was originally used for children with DCD, the study aimed to examine its effectiveness in children with handwriting difficulties. The results of the study revealed that CO-OP approach was beneficial for children with handwriting difficulties in achieving motor based occupational performance goals[7].

Performance and satisfaction in handwriting post CO-OP intervention:

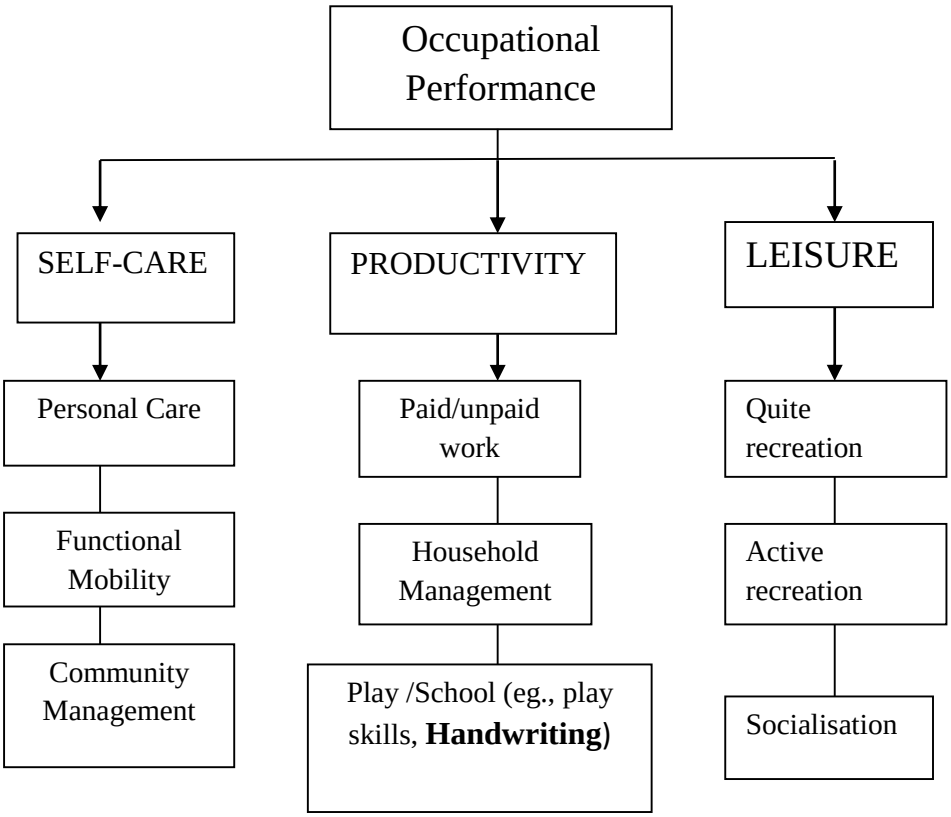
Ashleigh Thornton, Melissa Licari, Siobhan Reid, Jodie Armstrong, Rachael Fallows &Catherine Elliott (Disability and Rehabilitation, 2015) did a study, "**Cognitive Orientation to (Daily) Occupational Performance intervention leads to improvements in impairments, activity and participation in children with Developmental Coordination Disorder"**, which aimed to determine if a 10-week group-based Cognitive Orientation to Daily Occupational Performance (CO-OP) intervention improved outcome measures across the impairment, activity and participation levels of the International Classification of Functioning, Disability and Health (ICF) framework. In this quasi-experimental, pre–post-test, 20 male children aged 8–10 years with a confirmed diagnosis of DCD participated in either the 10 week group intervention based on the CO-OP framework ($n = 10$) or in a control period of

regular activity for 10 weeks ($n = 10$). All children identified fine motor goals of handwriting speed and legibility; other fine motor goals included using scissors and cutlery appropriately. The therapists used a Police Detective puppet to introduce the ‘‘Goal-Plan-Do-Check’’ strategy to help solve (performance) problems. *Goal* is the task that the child wishes to perform (e.g. handwriting). *Plan* refers to how the child will tackle the goal (involving specific strategies). *Do* refers to the performance of the task, requiring the child to practice. *Check* is the child's evaluation of the strategies employed and whether they were successful. Outcome measures relating to impairment (MABC-2, motor overflow assessment), activity (Handwriting Speed Test) and participation [Canadian Occupational Performance Measure, (COPM) and Goal Attainment Scale) were measured at weeks 0 and 10 in the intervention group. . Parent and child **performance and satisfaction** ratings on the COPM and all goals were achieved at or above the expected outcome. They concluded that strategies implemented by children in the CO-OP treatment group, targeted towards individualised goal attainment, show that CO-OP, when run in a group environment, can lead to improvements across all levels of the ICF. The study concluded that CO-OP is an approach which uses cognitive-based strategies to improve performance of specific tasks based on child chosen goals. The intervention program had a positive effect on self-perceived levels of performance. Parents felt the intervention enhanced socialisation, peer modelling and encouragement and felt that this increased confidence and independence[25].

Shannon Taylor, Nora Fayed, Angela Mandich did a study (IJOT, 2007), **"CO-OP intervention for young children with Developmental Coordination Disorder"** Children with developmental coordination disorder experience difficulties with fine and gross motor tasks that affect their occupational performance. The purpose of this single-case design study was to determine the effectiveness of using the CO-OP approach with children ages 5 to 7 years. Four children chose three different goals to work on during therapy. Child and parent Canadian Occupational Performance Measure **ratings and performance** observation ratings at follow-up demonstrated the effectiveness of the CO-OP approach, supporting the use of the CO-OP with younger children. Suggested further research on the CO-OP with younger children is needed[26].

CONCEPTUAL FRAMEWORK

Occupational performance is classified into self care, productivity and leisure. Productivity includes: paid/unpaid work, household management, play/school. The last component of play/school includes play skills, reading, doing calculations, problem solving and writing homework. Among all this occupations, handwriting occupies majority of the day's work at school. It is the primary form of written expression the child learns to express themselves. Therefore it is essential the occupational therapist address the problems of handwriting especially when it is affected in children such as with DCD.



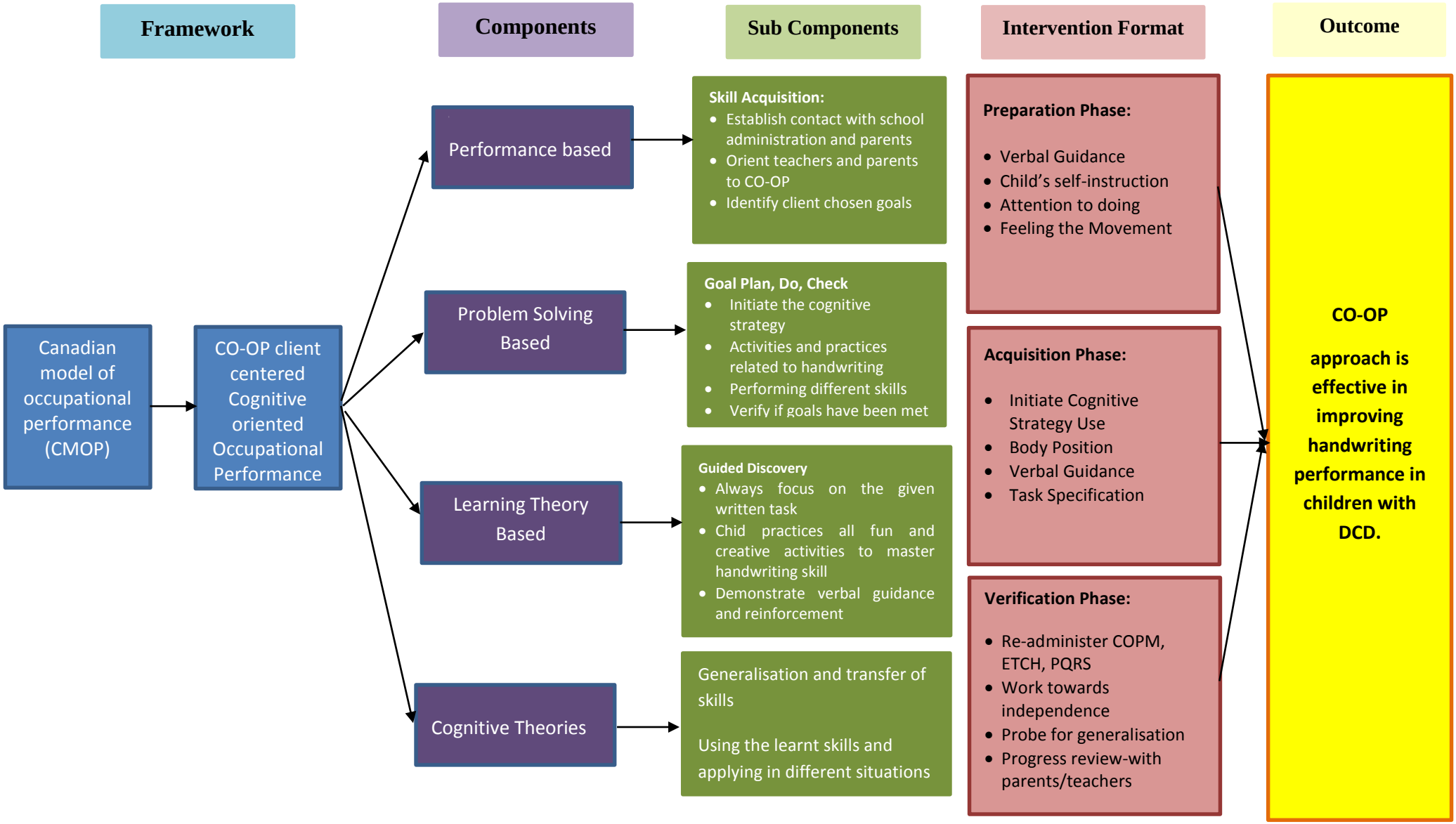
An occupational therapist plans treatment using process-oriented approaches such as sensory integrative approach, sensorimotor approach and task-oriented approaches such as compensatory skill development approach and neuro-motor task training and use of cognitive strategies, among which task oriented has been proved to reveal promising results. Among these task oriented approaches, the CO-OP approach has been developed especially for the children with DCD and it has been used to widely to address various components of Occupational Performance and it has been proven successful[9].

CO-OP is an approach which is based on client centeredness which is a fundamental element of the approach and it utilizes cognitive behavior modification and verbal self instruction. Hence the approach was initially named as Verbal Self-Guidance (VSG) and it was later changed to CO-OP. It was developed by Mandich A, Polatajko HJ, derived from their Canadian Model of Occupational Performance (CMOP). The global strategy which is problem-solving strategy was derived from the work of Meichenbaum (1977) which provides a structure through which the child can talk through the occupational performance goals. The domain specific strategies are used in specific tasks or situations to help achieve occupational performance goals. Therefore there is interaction between the person, environment and occupation elements, in which any change if it occurs will ultimately have an impact on performance.

CO-OP approach is the intervention used by the researcher in this study. Research has shown that Children have showed improved meta-cognitive skills in the action domain following participation in the CO-OP program, thus improving their ability to apply and monitor cognitive strategies in working through an occupational performance problem. Remediation of body positioning and action sequencing difficulties through the application of cognitive strategies during occupational performance can be achieved through improved meta-cognitive knowledge and skills following CO-OP treatment might assist children with DCD. Once the child learns this, the last step is generalisation and transfer of skills and problem solving strategies that have been learned in therapy and applying it in their everyday life.

The researcher has based her study upon the following concepts:

- Children with DCD have handwriting problems
- Children with DCD can identify problems in their handwriting and are able to set performance goals for improving it.
- Children with DCD when guided can develop their own cognitive strategies for self instruction and self-direction to improve handwriting
- Goal setting and development of cognitive strategies into meta-cognition will give a high level of satisfaction in their performance for children with DCD.


Framework
Components
Sub Components
Intervention Format
Outcome
Canadian model of occupational performance (CMOP)
CO-OP client centered Cognitive oriented Occupational Performance
Performance based
Problem Solving Based
Learning Theory Based
Cognitive Theories
Skill Acquisition:
Establish contact with school administration and parents
Orient teachers and parents to CO-OP
Identify client chosen goals
Goal Plan, Do, Check
Initiate the cognitive strategy
Activities and practices related to handwriting
Performing different skills
Verify if goals have been met
Guided Discovery
Always focus on the given written task
Chid practices all fun and creative activities to master handwriting skill
Demonstrate verbal guidance and reinforcement
Generalisation and transfer of skills
Using the learnt skills and applying in different situations
Preparation Phase:
Verbal Guidance
Child's self-instruction
Attention to doing
Feeling the Movement
Acquisition Phase:
Initiate Cognitive Strategy Use
Body Position
Verbal Guidance
Task Specification
Verification Phase:
Re-administer COPM, ETCH, PQRS
Work towards independence
Probe for generalisation
Progress review-with parents/teachers
CO-OP approach is effective in improving handwriting performance in children with DCD.

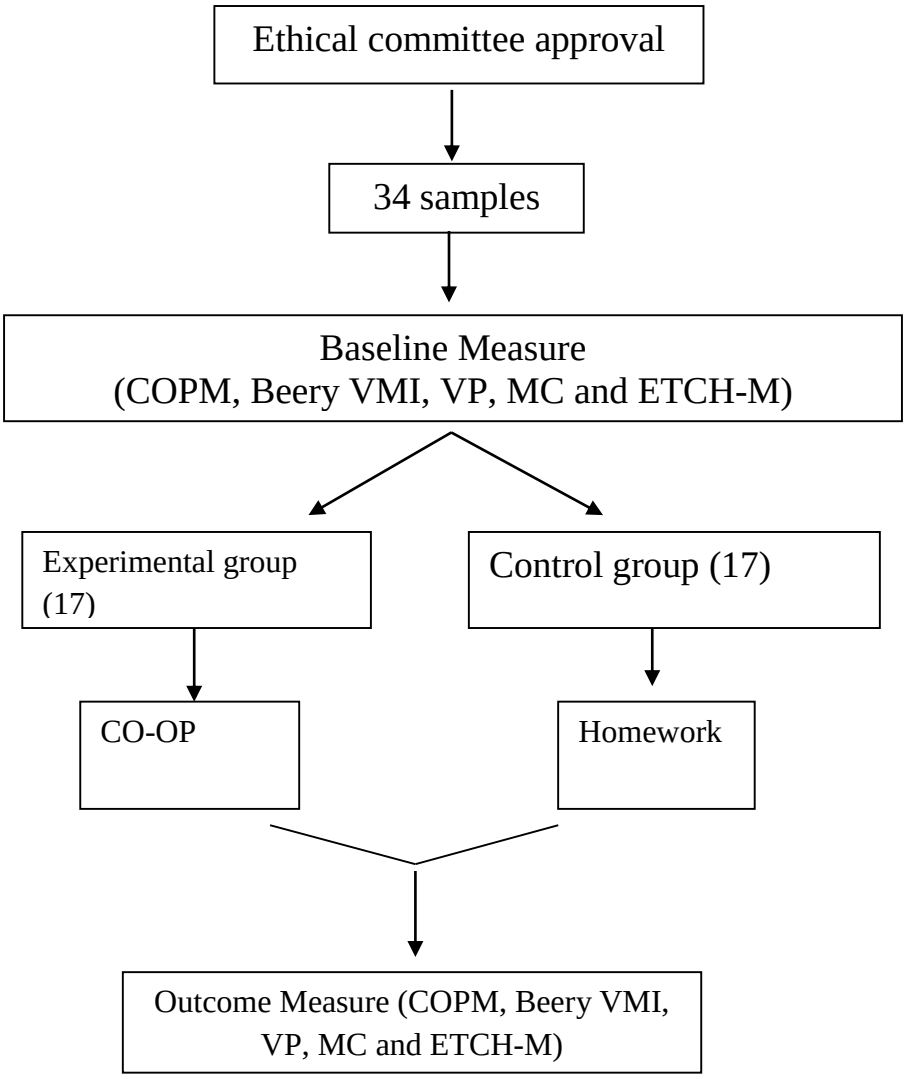
METHODOLOGY

Research Design: 2 group Quasi experimental pre-post test design was adopted for the study.

Experimental group underwent CO-OP intervention and control group underwent conventional occupational therapy intervention.

Ethical consideration was obtained from the institutions where the study was conducted. Informed consent form was obtained from the parents of the children who participated in the study.

Schematic Representation of the Research Design



Setting of the Study:

The study was conducted in and around Coimbatore which includes,

- Department of occupational therapy, Kovai Medical Centre and Coimbatore.
- Rashmika Centre for Learning and Counselling, Ramanathapuram, Coimbatore
- Cognito Academy for Learning Achievement, Sivanantha Colony, Coimbatore.

Sampling:

Convenience sampling method was used to select the sample based on criteria.

Sample population:

34 children were screened for DCD with a potential for handwriting issues and they were included for the study .

Sample size:

Sample size was determined using effect size. Effect size was calculated with the formula,

Effect size (ES):

$$\text{Group size (N)} = AB/ (ES)^2$$

Where $A= (1/q_1 + 1q_0)$ $B= (Z\alpha + Z\beta)^2$

Where q_1 is the proportion of subjects that are in group 1 exposed to treatment,

q_0 is the proportion of subjects in group 2 unexposed to treatment,

E is the effect size

S is the standard deviation of the outcome in the population.

$Z\alpha$ is the normal standard deviate for α

(α – threshold probability for rejecting the null hypothesis. Type I error)

$Z\beta$ is the normal standard deviate for β.

(β- Probability of failing to reject the null hypothesis under alternate hypothesis. Type II error)

Normal approximation was calculated using Z statistics.

The study included 34 samples

- Experimental group:17
- Control group:17

Duration of intervention: One session per week for 12 weeks (12 sessions for experimental group and 12 sessions for control group). Each session was for 45 minutes to 1 hour.

Selection Criteria

Inclusion criteria:

Children with a diagnosis of DCD, scoring 15-46 in DCDQ (indication of DCD or suspect of DCD). (children who may have a co-morbidity of LD will also included for the study)

Age group: 6 years, both boys and girls, with either hand dominancy.

Children who had 'Below average, low and very low scores in Beery Buktenika scale for Visual-motor integration, Visual-Perception and motor coordination.

Exclusion Criteria:

Children with physical disorders, conditions such as autism, ADHD, severe and profound Mental retardation etc.

Children taking additional tuitions or special coaching for improving handwriting.

Variables:

Independent variable: CO-OP approach

Dependent variable: Handwriting improves or remains same

Extraneous Variable: Absenteeism of children at school.

Tools, Equipments and Outcome Measures

Developmental coordination Questionnaire 2007:

The Developmental Coordination Questionnaire (DCDQ) is a parent report measure developed to assist in the identification of Developmental Coordination Disorder (DCD) in children. It was developed initially in the late 90's by B.N. Wilson and S.G. Crawford at the Alberta Children's Hospital, Calgary, Canada and was later revised in 2007, administered for children aged 5 to 15 years. Parents are asked to compare their child's motor performance to that of his/her peers using a 5 point Likert scale. It provides a standard method to measure a child's coordination in everyday, functional activities. The internal consistency of the DCDQ is high and the results from discriminant function analyses were appropriately strong for it as a screening tool. The DCDQ'07 consists of 15 items, which group into three distinct factors. The first factor "Control during Movement". The second factor contains "Fine Motor and Handwriting" and the third factor relates to "General Coordination".

***Psychometric properties*:** Age group 5 years to 7years 11 months: Sensitivity = 75.0% and Specificity = 71.4% , 8 years to 9 years 11 months: Sensitivity = 88.6% and specificity = 66.7%, 10 years to 15 years: sensitivity = 88.5% and specificity = 75.6%. The overall sensitivity is 84.6% and the specificity is 70.8%.

Beery Buktenica scale of VMI

The Beery VMI was developed by Keith E. Beery, Natasha A. Beery and Norman A. Buktenica in 2009 and standardised in 2010. Can be administered from ages 2 through 18. It measures the extent to which individuals can integrate their visual and motor abilities. Used to identify children who are having significant difficulty with visual-motor integration and to determine the most appropriate course of action. The test can be used as an outcome measure to assess the effectiveness of education and intervention programs. The respondent is asked to copy geometric drawings onto a form. The drawings are presented in order of increasing difficulty. Distinct Visual Perception and Motor Coordination subtests are included, making it possible to test one skill set to the exclusion of the other. Scoring is completed on the form.

Visual-Motor Integration

Visual Perception

Motor Coordination

Psychometric properties: Mean content reliability = 0.93 – 0.96 and mean person reliability = 0.83 – 0.84 Internal consistency = 0.95, internal consistency using Cronbach's Alphy = 0.96 (very good for clinical purposes) Interrater reliability = 0.93

Evaluation Tool for Children's Handwriting (ETCH – M):

The ETCH is a criterion-referenced tool developed by Amundson in 1995 which was designed to evaluate manuscript and cursive handwriting skills of children in Grades 1 through 6. Its focus is to assess a student's legibility and speed of handwriting tasks similar to those required of students in the classroom. The test takes about 15 minutes for completion and 25 minutes for scoring. ETCH tasks include alphabet and numerical writing, near-point and far-point copying, dictation, and sentence generation. Assesses legibility components, pencil grasp, hand preference, pencil pressure, manipulative skills with the writing tool, and classroom observations. Scoring: legibility, number of tasks and speed. A scoring standard for legible letters and words has been established. An inter-rater reliability study is complete for the ETCH-Manuscript.

Psychometric properties: Test-retest reliability: letter legibility = 0.77 and numeral legibility = 0.63 individual task reliability: Near point copying = 0.20 and alphabet upper case = 0.76

Canadian occupational performance measure (COPM): (Mary law, Sue Baptiste, Anne Carswell, Mary Ann McColl, Helene J. Polatajko and Nancy Pollock, COPM , 3rd edition), evaluates changes in children perception of their performance and satisfaction in identified activities. Caregivers identify issues in self care, productivity and leisure and rate performance and satisfaction scores ranging from 1 to 10. In the current study COPM is given to parents to rate their child's handwriting performance and satisfaction.

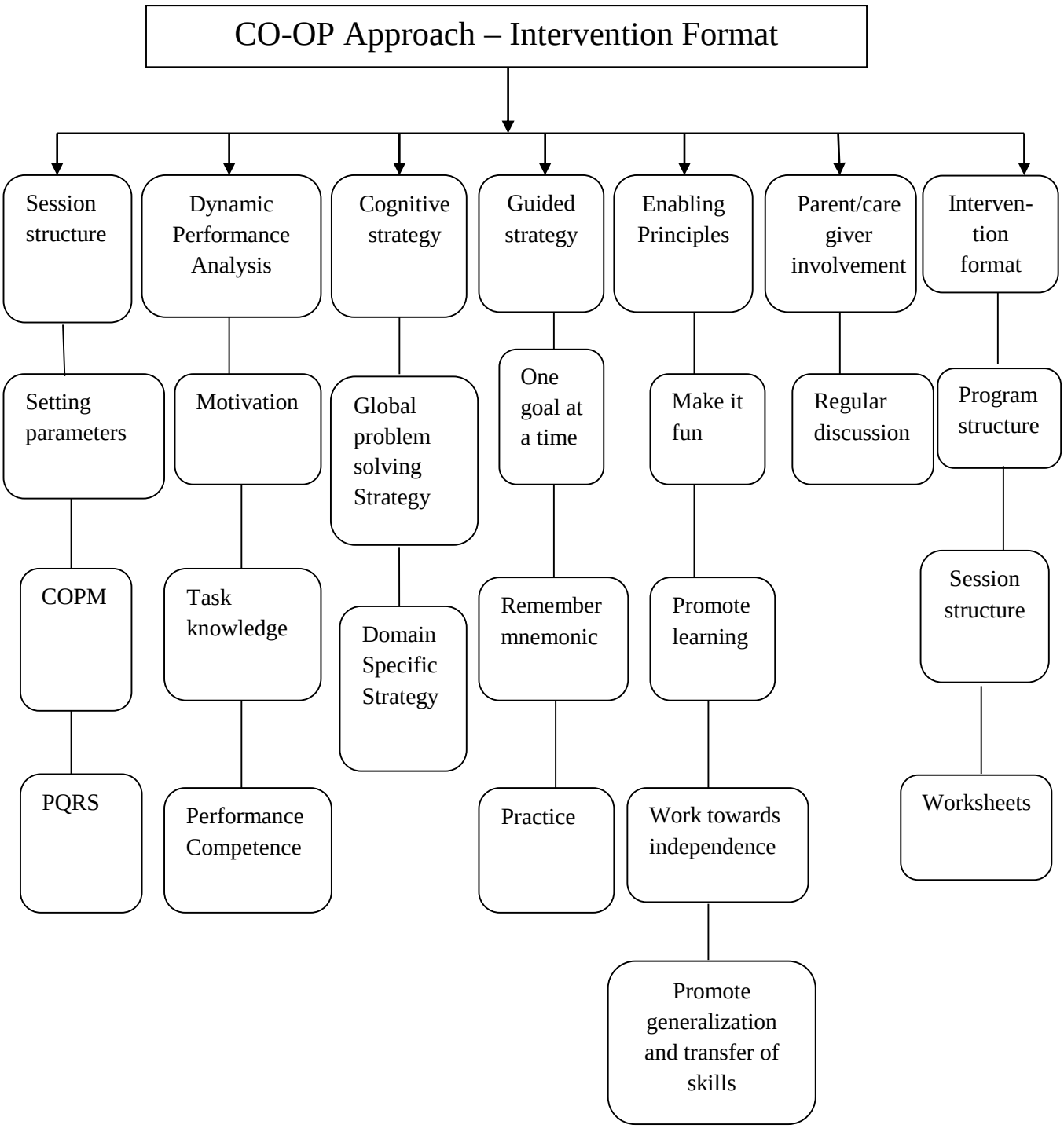
Psychometric properties: Reliability= 0.63 and 0.84. Test retest reliability= 0.79 and 0.75. Internal consistency for performance = 0.41- 0.56 and satisfaction=0.71.

Procedure:

- Ethical clearance from institutional ethical board was obtained to conduct the study.
- A written consent was obtained from the head of the schools to conduct the study.
- The purpose of the study was explained and written informed consent was obtained from the parents prior to the study.
- Using convenient sampling, 34children were selected they were divided into 2 groups randomly: experimental and control,17 in each.
- Baseline measures were collected using Beery scale of Visual motor coordination, Visual perception and motor coordination, ETCH-Manuscript and COPM.
- Both experimental and control group were undergoing regular occupational therapy session.
- The duration of the intervention was for 10 weeks – one session per week for control and experimental group.
- The duration of each session was 45 minutes to 1 hour.
- After 12 weeks of intervention, the post test was taken by using ETCH-M. After 12 sessions of intervention, teachers were given COPM to score the post-intervention performance and satisfaction of the children and the results were analyzed.
- Conventional therapy included handwriting practices with 2 lined worksheets and 4 lined worksheets, copying passages from book and black board with pencil.
- Starting with alphabets, two letter words and three letter words.

SESSION STRUCTURE: CO-OP INTERVENTION PROTOCOL

Prior to therapy	Preparation 1. Establish contact with parents. 2. Orient parents to CO-OP approach. 3. Orients parents about regular worksheet completion 4. Check for child/parent and therapist prerequisites
	Assessment 5. Administer COPM 6. Orient child regarding goal setting and help them in identifying goals 7. Asses baseline of child's performance using PQRS
Session 1	Introduction to **Global strategies** ***8.*** Introduce Goal-plan-Do-check to the child ***9.*** Researcher performs goal-plan-do-check ***10.*** Child performs goal-plan-do-check with the set goal
Session 2 - 12	**Acquisition –** child has acquired the set goals in these sessions. **11.** Facilitate child's acquisition and application of global strategies: Goal-Plan-Do-Check **12.** Guided discovery of Domain Specific Strategy (DSS) and facilitate its application in skill acquisition **13.** Apply the enabling principles **14.** Orient parents/teachers about global strategy and applicable domain specific strategies **15.** Educate parents about continuing the use of these strategies to promote skill acquisition **16.** Administer PQRS week-wise to monitor child's performance
Post test	**Consolidation** 17. Re-administer COPM 18. Re-administer outcome measures 19. Probe child for generalisation and transfer of global and domain specific strategies.


CO-OP Approach – Intervention Format
Session structure
Dynamic Performance Analysis
Cognitive strategy
Guided strategy
Enabling Principles
Parent/care giver involvement
Interven-tion format
Setting parameters
Motivation
Global problem solving Strategy
One goal at a time
Make it fun
Regular discussion
Program structure
COPM
Task knowledge
Domain Specific Strategy
Remember mnemonic
Promote learning
Session structure
PQRS
Performance Competence
Practice
Work towards independence
Worksheets
Promote generalization and transfer of skills

CO-OP Intervention Group:

CO-OP intervention was given to the children based on their each individualised child set goals.

Children were taught global strategies of GOAL-PLAN-DO-CHECK and domain specific strategies (DSS) during the second session.

They were taught to apply these strategies during handwriting practice sessions. The sessions for each child included 45 minutes – 1 hour.

Performance Quality Rating Scale (PQRS) was rated during each week in the individual sessions depending on the child's performance.

The children were taught generalisation of the learnt strategies by writing on textured materials other than paper, such as writing on raised lines, tracing and writing on thickened butter paper and writing on the board.

Intervention continued for 12 weeks, one session per week and each session of 45 minutes – 1 hour and the same intervention was continued by the teachers and parents. At the end of 12 weeks, post test was taken using Beery VMI,VP and MC, ETCH-Manuscript and teachers were given COPM, to rate the performance and satisfaction of handwriting performance of the children.

Goal Plan do Check

All the children involved in the study were able to apply the global strategies of Goal, Plan, Do and Check.

Goal

The children were initially oriented to the process of global strategies. They were asked to compare their handwriting with the handwriting of a child in their classroom whose handwriting was comparatively better. The children were able to identify the larger prints, the reversal of letter in their handwriting, which was set as their individual goals for the 12 weeks of intervention. Each child set one goal which they aimed to achieve by the end of the intervention period. The children in the

experimental group set goals such as letters should be big in size, the spacing should improve, the reversal of letters should be corrected, to improve legibility etc.

Plan

The strategy of planning was taught to each child according to the goal they had set. Age was also an influential factor. The children in the older age group such as above 10 years, were able to plan how to acheieve their goals compared to 8 year old children who needed much assistance. The children were taught planning by asking them which surface of writing would be easier for them to achieve their goals. Such as writing on a four lined note book or a two lined note book with larger space in between. Some children preferred checkered notebook as it helped then to stay in line and also reminded them about spacing.

Do

'Do' was the task performance. The children were asked to copy lines from board, from text books, from story books. They were made to write on different textures such as on black board, on paper, on worksheets, on raised lines, on butter paper, on the notebooks of their choice, on chart papers with different angled lines and shapes. These activities made the children to stay focused on their task because of novel writing surfaces. They were able to see their printing on different surfaces which helped them to improve handwriting performance as a whole.

Check

Checking strategy was taught by making the children compare their handwriting to the previous day's or previous week and it helped them to see if they are improving or still needing improving. The children were rewarded with a star if shown improvement and were encouraged to follow the same in other settings such as classroom. Other children were motivated to keep trying for the next week.

Age seemed to affect the range of strategies used by the children. The older children were able to actively apply the domain specific strategies of proper body positioning, self-talk and verbal instruction compared to the younger children who needed constant prompting and reminding. After 3 weeks of intervention, the children

were able to understand the concept of the intervention and they were actively involved in applying other strategies such as feeling the movment and attention to doing as they performed their tasks. The teachers were also told to encourage the children to motivate them to apply these techniques in the classroom setting as well for generalisation of the learned skills.

Domain Specific Strategies

The children were taught to use strategies of DSS. Initially the researcher guided the children in applying these strategies such as body position, feeling the movement, verbal script, self-instruction etc. Towards the later sessions the children were able to apply these strategies by themselves during task performance. The children were taught generalization and transfer of learning so that they can apply the learnt skills in other settings, such as home and classroom.

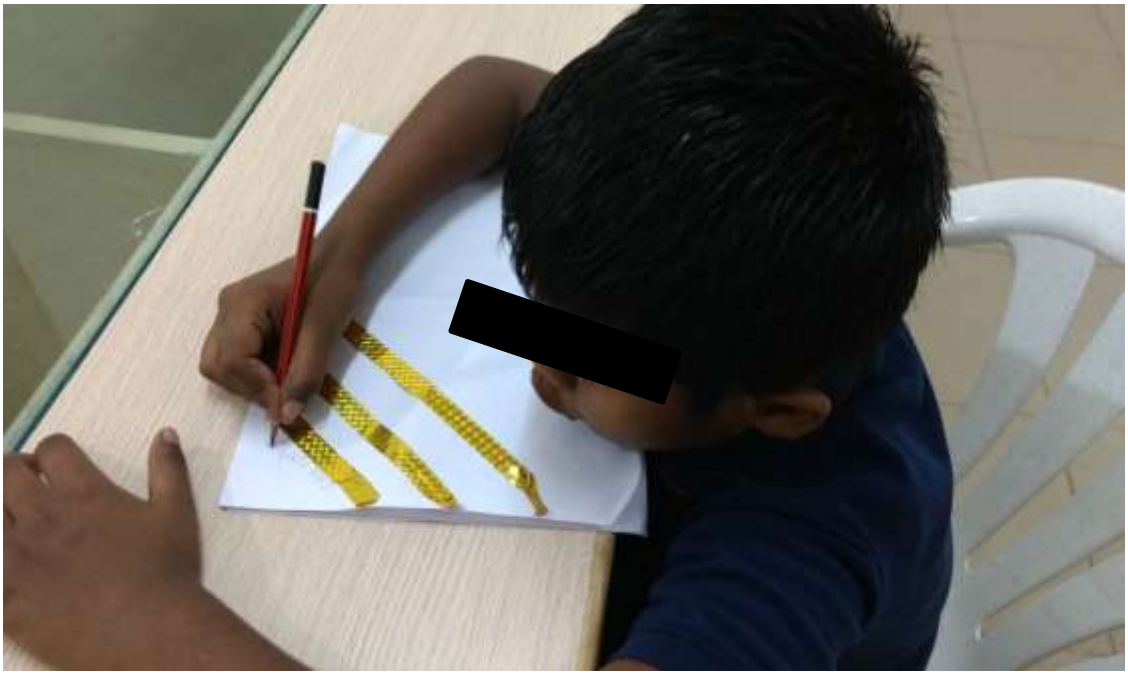
Intervention for the Control Group:

Children in the control group were given homework of writing in four lines and two lines notebook, one page per week. The homework was checked every week and suggestions were given to the child and the teacher for correcting mistakes and for further improvements in handwriting were suggested.

At the end of 12 weeks, post-test was taken using Beery VMI,VP and MC, ETCH-Manuscript and teachers were given COPM, to rate the performance and satisfaction of handwriting performance of the children.

Researcher teaches the child to apply strategies of "feeling the movement" – Domain Specific Strategy

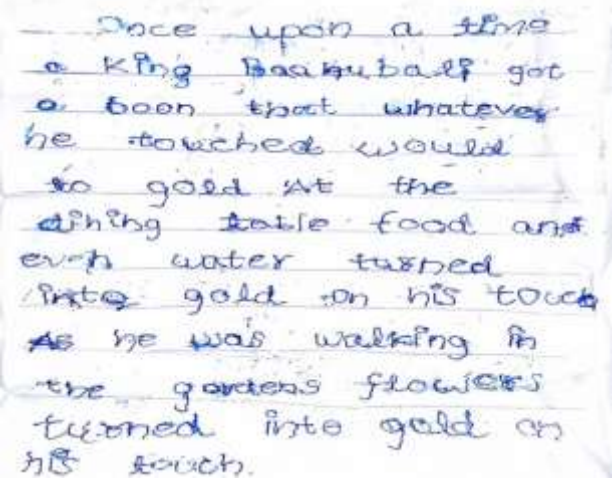
Child performs self-instruction during task performance.



Writing on Raised Lines

Writing on Black Board

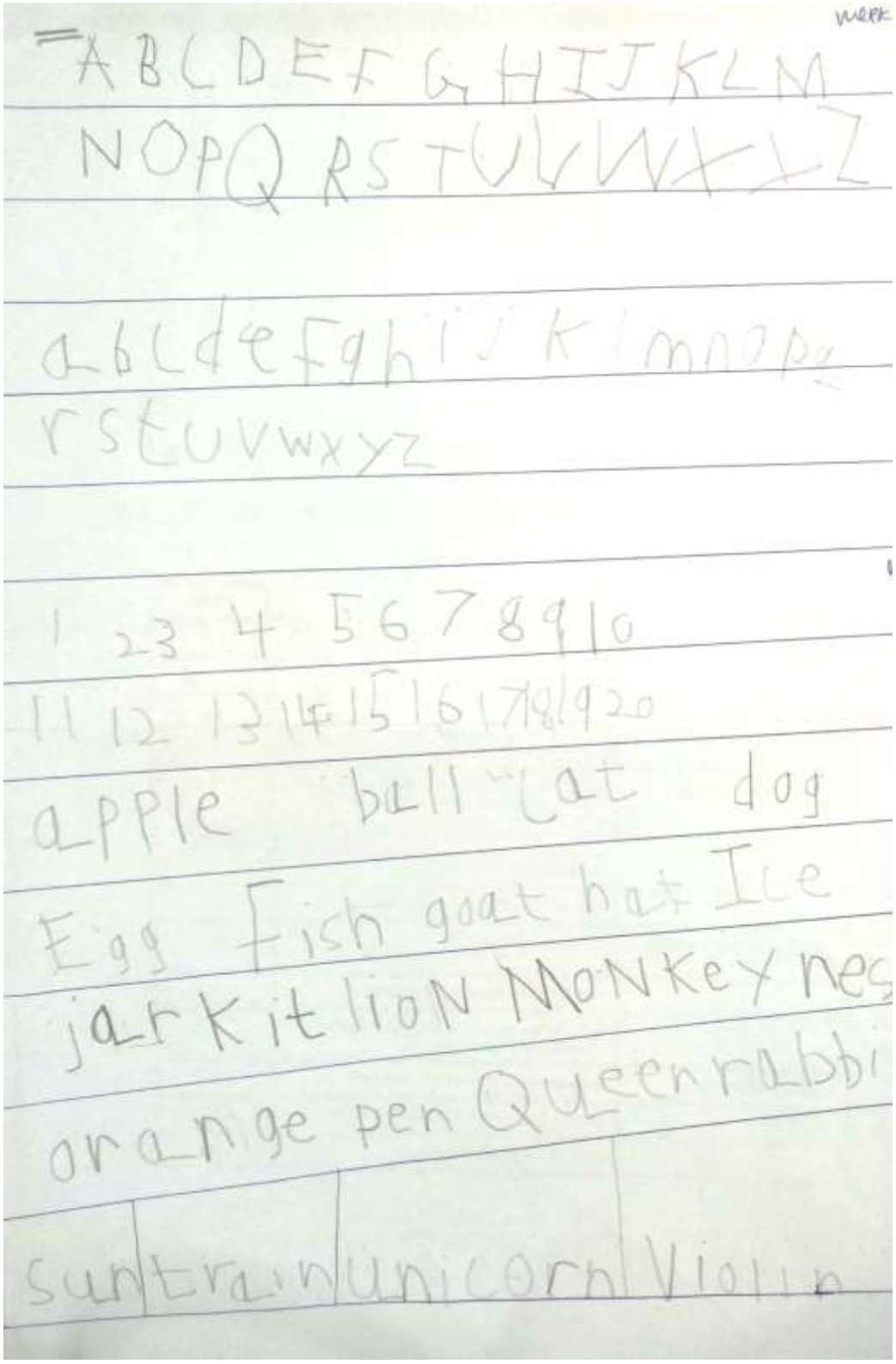
Writing on Tracing Paper


Once upon a time a King Baakubali got a boon that whatever he touched would to gold At the dining table food and even water turned into gold on his touch As he was walking in the gardens flowers turned into gold on his touch.

Researcher teaches the child to apply the cognitive strategies while involving in Task Performance

Child corrects his body position while engaging in Task Performance

Handwriting Practice by the Control Group



DATA ANALYSIS

To determine the effectiveness of handwriting in children with DCD, the scales administered were Beery Buktenica scale of VMI, VP and MC, ETCH – Manuscript, COPM and PQRS. The scores obtained from these scales were subjected to statistical analyses. All statistical analyses was done using SPSS 20 version. 34 children who had Developmental Coordination Disorder were screened using Developmental Coordination Disorder Questionnaire and were taken for the study. They were divided into 2 groups, 17 in experimental and 17 in control group. The CO-OP approach was given as intervention for experimental group and handwriting practice was suggested as homework for control group. Pre-test was done initially followed by 12 weeks of intervention, after which post-test was administered.

Statistical tests used were Shapiro-Wilk's test to determine the normality of sample distribution and descriptive analyses was performed to compare the performances of the groups using Wilcoxon and Mann Whitney U tests.

Shapiro – Wilk's test was used to determine if the sample population was normally distributed. The significance value of the test significantly deviated from a normal distribution except for one component. Therefore, non-parametric test was used.

Wilcoxon signed rank test was used for within the group comparison.

Mann-whitney U test was used for comparison between the groups.

Table 1.1. Screening of the participants using DCDQ.

Age group	N	DCDQ Score	Mean	S.D
6 years – 7 years 11 months	0	15-46	0	0
8years – 9years 11months	18	15-55	21.53	22.18
10 years –15years 11 months	16	15-57	25.38	25.85

The above table shows the mean and standard deviation of DCDQ scores of children in respective age group.

Table 1.2: Demographic details of the participants in the study

Group	N	Gender (N)		Mean& SD
		Boys	Girls	
Experimental	17	13	4	9.18 ± 0.94
Control	17	15	2	9.22 ± 0.89

The above table shows that there were 13 boys and 4 girls in the experimental group and 15 boys and 2 girls in the control group. The mean age of experimental group was 9.18 ± 0.94 and that of control group was 9.22 ± 0.89.

Table 2.1: Descriptive Statistic of Canadian Occupational Performance Measure: Performance and Satisfaction component

Outcome measure	Group	Test	Mean	SD	Min	Max
Performance	Experimental	Pre	3.76	1.20	1	5
		Post	5.29	1.68	2	8
	Control	Pre	2.94	0.96	1	4
		Post	3.00	1.11	1	5
Satisfaction	Experimental	Pre	2.59	1.27	1	5
		Post	4.24	1.48	2	7
	Control	Pre	2.59	0.53	1	5
		Post	2.88	1.11	1	5

The above table shows the descriptive statistic and mean value of Canadian Occupational Performance Measure: performance and satisfaction component in the experimental and control group.

Table 2.2: Comparison of Components of COPM within the Groups

Domains	Group	Test	Positive rank	Negative rank	Ties	Z score	Sig (2tailed)
Performance	Experimental	Posttest- Pretest	14	1	2	-2.596	**0.009**
	Control	Posttest- Pretest	4	2	11	-0.333	0.739
Satisfaction	Experimental	Posttest- Pretest	16	0	1	-3.584	**0.000**
	Control	Posttest- Pretest	6	1	10	-1.890	0.59

The above table shows the results of Wilcoxon test, indicating a significant difference in the performance and satisfaction component of experimental group but not in the control group.

Table 2.3: Comparison between Control and Experimental Group Scores of COPM

Test	Outcome measure	Group	N	Mean Rank	Sum of rank	U score	Sig (2tailed)
Pre-test	Performance	Experimental	17	21.03	357.50	84.50	**0.033**
		Control	17	13.97	237.50		
	Satisfaction	Experimental	17	17.32	294.50	141.50	0.91
		Control	17	17.68	300.50		
Posttest	Performance	Experimental	17	23.62	401.50	40.50	**0.00**
		Control	17	11.38	193.50		
	Satisfaction	Experimental	17	22.00	374.00	68.00	**0.007**
		Control	17	13.00	221.00		

Graph 2.1: Graphical representation of Comparison between control and experimental group scores of COPM (Handwriting alone)

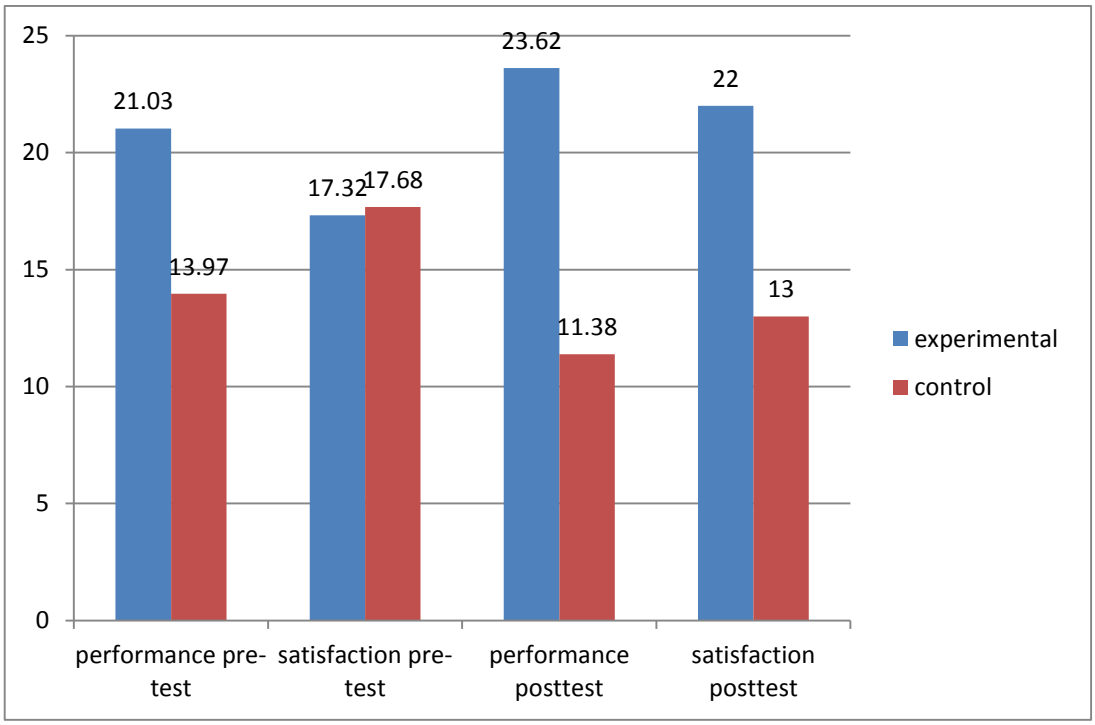


Table 2.2 & Graph 2.1: The above table shows comparison between the groups for COPM components, indicating significant difference in the performance component of pre-test and performance and satisfaction component of post-test.

Table 3.1 Descriptive Statistic of Beery Buktenica VMI, VP, MC Pretest Scores

Components	Group	Mean	Std dev	min	Max
Visual Motor Integration(VMI)	Experimental	68.35	7.00	56	81
	Control	50.29	25.29	0	75
Visual Perception (VP)	Exp	55.94	27.79	0	87
	Con	44.53	26.95	0	71
Motor Coordination (MC)	Exp	57.41	28.20	0	86
	Con	46.35	27.75	0	72

The above table shows the descriptive statistics and mean value of Beery Buktenica scale of VMI, VP and MC – pretest scores.

Table 3.2 Descriptive Scores of Beery Buktenica VMI, VP and MC Post Test Scores

Components	Group	Mean	Std dev	Min	Max
Visual Motor Integrtion (VMI)	Exp	76.18	7.08	65	92
	Con	54.41	22.71	0	78
Visual Perception (VP)	Exp	70.47	14.08	45	91
	Con	50.18	21.24	0	75
Motor Coordintion (MC)	Exp	71.76	14.08	45	94
	Con	50.59	26.32	0	76

The above table shows the descriptive statistics and mean value of Beery Buktenica scale of VMI, VP and MC – posttest scores.

Table 3.3 Comparison of Pre and Post test scores of VMI, VP and MC in Experimental Group

Components	Groups	Positive Rank	Negative Rank	Ties	Z score	Sig (2 tailed)
Visual Motor Integration (VMI)	**Post-Pre**	9.00	0.00	0	-3.642	**0.00**
Visual Perception (VP)	**Post-Pre**	9.00	0.00	0	-3.630	**0.00**
Motor Coordination (MC)	**Post-Pre**	9.00	0.00	0	-3.632	**0.00**

Graph 3.1 Showing the comparison of Pre and Posttest scores of VMI, VP and MC in Experimental Group

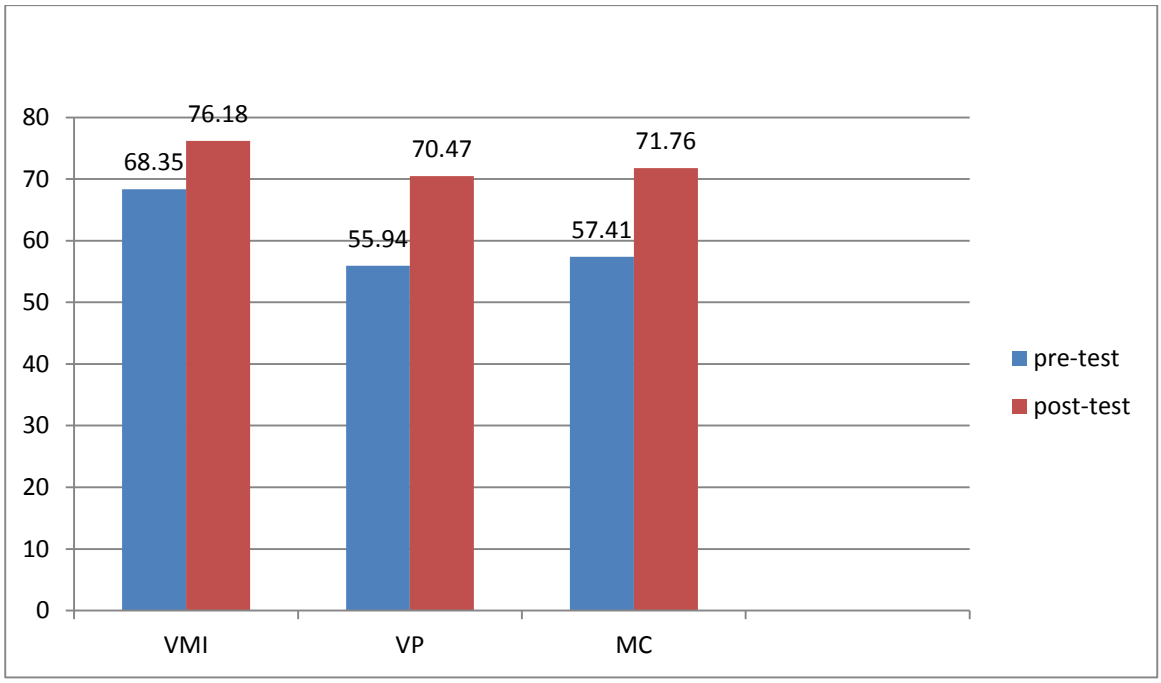


Table 3.3 & Graph 3.1 The above table shows the results of Wilcoxon test within the group comparison of VMI, VP and MC scores in the experimental group indicating significant difference in all the three components.

Table 3.4 Comparison of Pre and Posttest scores of VMI, VP and MC in Control Group

Components	Groups	Positive Rank	Negative Rank	Ties	Z score	Sig (2 tailed)
Visual Motor Integration (VMI)	**Post-pre**	6.50	8.67	4	-1.380	0.168
Visual Perception (VP)	**Post-pre**	4.50	4.50	9	-1.265	0.206
Motor Coordination (MC)	**Post-pre**	4.00	0.00	10	-2.384	0.17

Graph 3.2 Showing the comparison of Pre and post test scores of VMI, VP and MC in Control Group

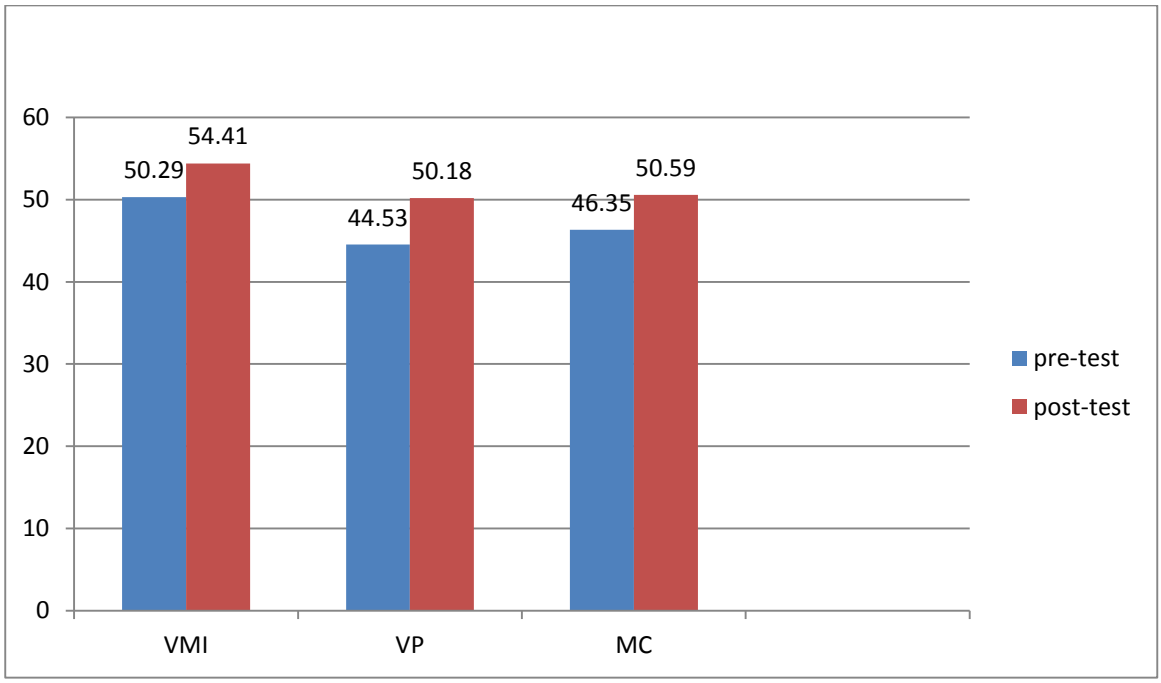


Table 3.4 & Graph 3.2: The above table shows the results of Wilcoxon test in within the group comparison of VMI, VP and MC scores in the control group indicating no significant difference in all the three components.

Table 3.5 Comparison of post test scores of VMI, VP and MC in Experimental and Control Group

Components	Group	Test	N	Mean Rank	Sum of Rank	U Score	Sig (2tailed)
Visual Motor Integration (VMI)	**Exp**	**Post-pre**	17	24.32	413.50	28.500	**0.00**
	Con	**Post-pre**	17	10.68	181.50		
Visual Perception (VP)	**Exp**	**Post-pre**	17	22.56	383.50	58.500	**0.00**
	Con	**Post-pre**	17	12.44	211.50		
Motor Coordination (MC)	**Exp**	**Post-pre**	17	22.47	382.00	60.00	**0.00**
	Con	**Post-pre**	17	12.53	213.00		

Graph 3.3 Showing the Comparison of Post test scores of VMI, VP and MC in Experimental and Control Group

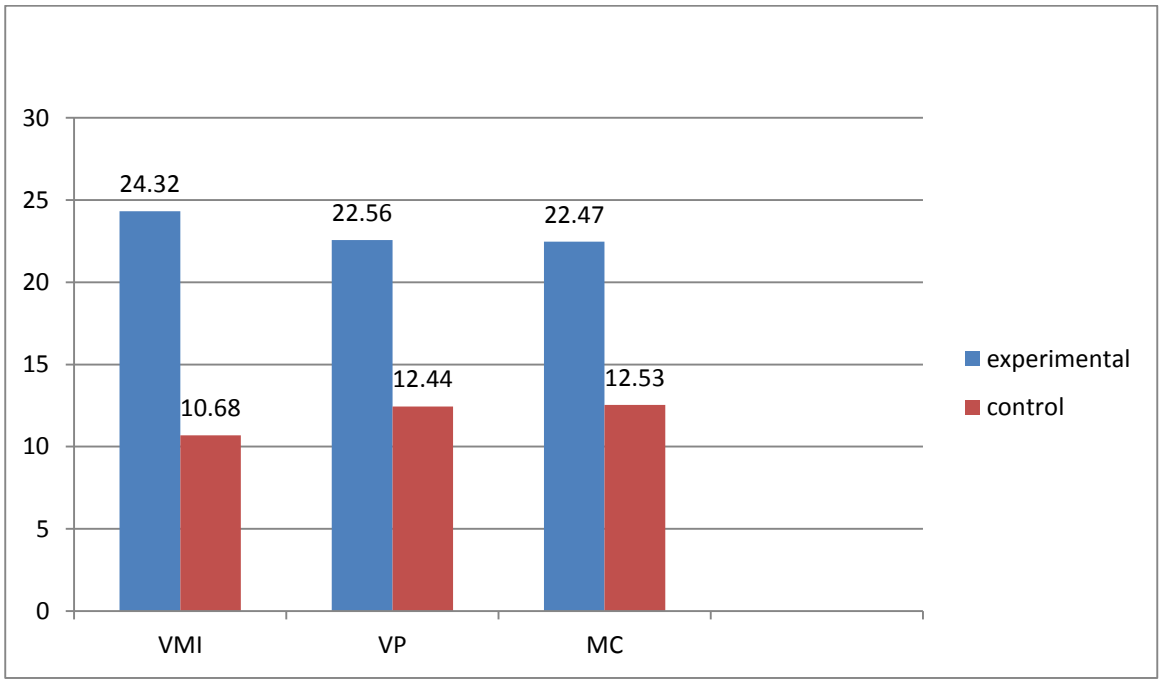


Table 3.5 & Graph 3.3: The above table shows the results of Mann-Whitney U test of between the group comparison of pre and post-tests revealing significant difference in VMI, VP and MC in the experimental group, indicating that the intervention was highly effective.

Table 4.1 Descriptive Statistic of Evaluation Tool of Children's Handwriting – Manuscript (ETCH-M) Pretest Scores

Components	Group	mean	Std dev	Min	Max
Word legibility (WL)	Exp	72.98	14.92	50.00	100.00
	Con	78.23	15.03	50.00	100.00
Letter legibility (LL)	Exp	67.43	20.26	36.73	89.32
	Con	68.01	16.00	39.79	92.23
Numeral legibility (NL)	Exp	91.69	11.96	64.70	100.00
	Con	91.00	12.14	70.58	100.00

The above table shows the descriptive statistics and mean value of the pre-test of WL, LL and NL components of ETCH-M scale.

Table 4.2 Descriptive Statistic of Evaluation Tool of Children's Handwriting – Manuscript (ETCH-M) Post-test Scores

Components	Group	Mean	Std dev	Min	Max
Word legibility (WL)	Exp	86.56	18.99	33.33	100.00
	Con	84.59	16.70	50.00	100.00
Letter legibility (LL)	Exp	90.75	12.06	67.12	100.00
	Con	71.33	17.25	41.83	97.08
Numeral legibility (NL)	Exp	96.13	6.88	82.35	100.00
	Con	91.69	8.59	64.70	100.00

The above table shows the descriptive statistics and mean value of the pre-test of WL, LL and NL components of ETCH-M scale.

Table 4.3 Comparison of Pre and Posttest Scores of ETCH - M in Experimental Group

Components	N	Positive Rank	Negative Rank	Ties	Z score	Sig (2 tailed)
Word Legibility Post-pre test	17	8.96	9.17	0	-2.324	**0.020**
Letter Legibility Post-pre test	17	9.00	0.00	0	-3.621	**0.000**
Numeral Legibility Post-pre test	17	5.00	1.00	9	-2.441	**0.015**

Graph 4.1 Showing comparison of Pre and Post test scores of ETCH-M in Experimental Group

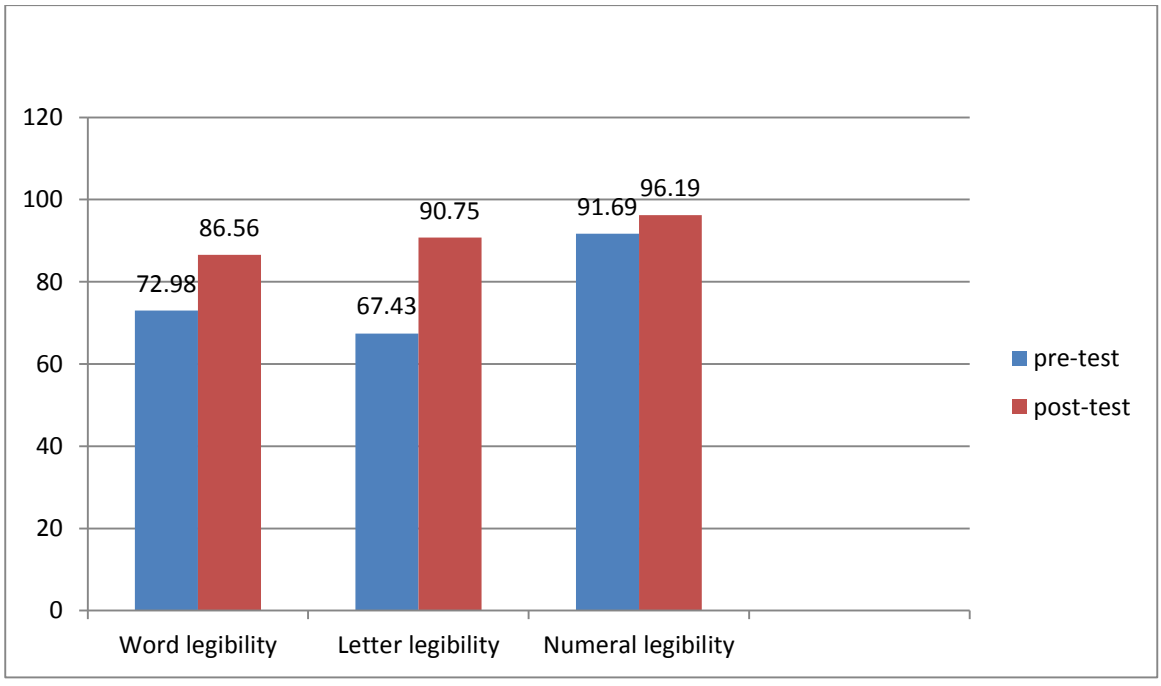


Table 4.3 & Graph 4.1: The above table shows within the group comparison of WL, LL and NL components of ETCH-M in the experimental group indicating significant difference in all the three components.

Table 4.4 Comparison of pre and post test scores of ETCH - M in Control Group

Components	N	Positive rank	Negative rank	Ties	Z score	Sig (2 tailed)
Word Legibility Post-pre test	17	4.71	3.00	9	-2.111	**0.035**
Letter Legibility Post-pre test	17	10.38	4.50	0	-2.779	**0.005**
Numeral Legibility Post-pre test	17	7.50	5.50	5	-0.473	0.636

Graph 4.2 Showing the Comparison of Pre and Post test Scores of ETCH - M in Control Group

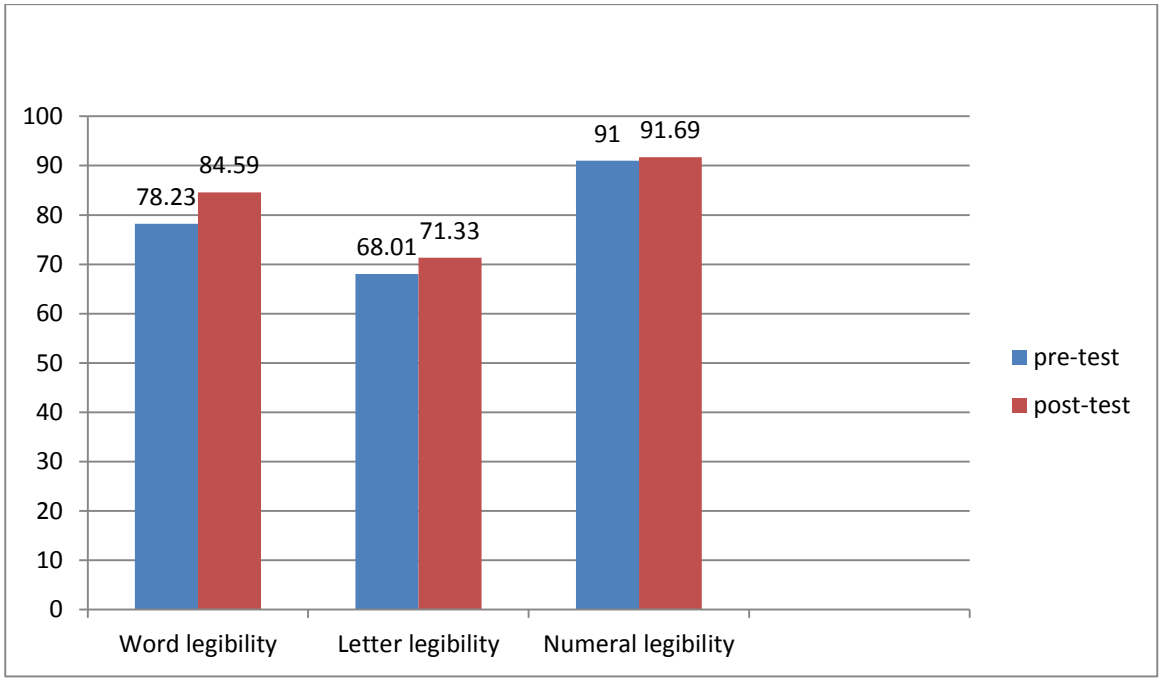


Table 4.4 & Graph 4.2: The above table shows within the group comparison of WL, LL and NL components of ETCH-M in the control group indicating significant difference in all the three components.

Table 4.5 Comparison between the Pre test scores of ETCH-M in Experimental and Control Group

Test	Outcome measure	Group	N	%	Mean Rank	Sum of Rank	U Score	Sig (2tailed)
Pre-test	**Word Legibility**	**Experimental**	17	72.98	15.82	269.00	116.00	0.323
		Control	17	78.23	19.18	326.00		
	Letter Legibility	**Experimental**	17	67.43	18.29	311.00	131.00	0.641
		Control	17	68.01	16.71	284.00		
	Numeral legibility	**Experimental**	17	91.69	17.29	294.00	141.00	0.894
		Control	17	91.00	17.71	301.00		

Graph 4.3 Showing the comparison between the Pre test scores of Experimental and Control Group following CO-OP Intervention

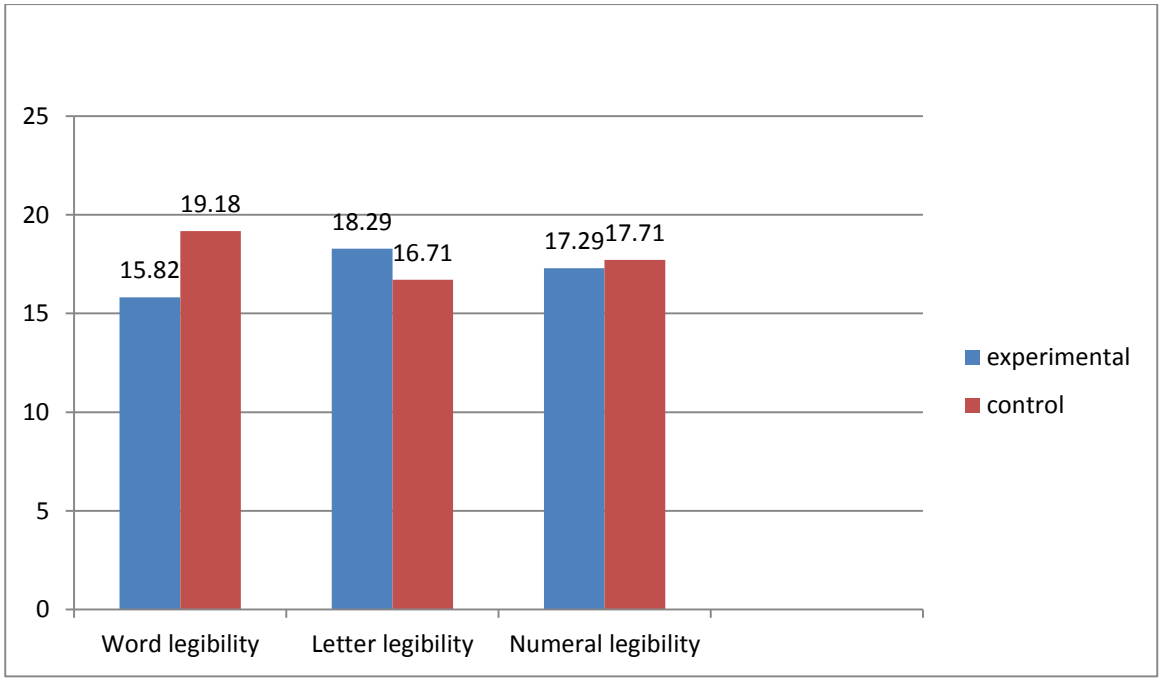


Table 4.5 & Graph 4.3: The above table shows the within the group comparison using Mann Whitney U test. There are no significant differences in the Pre and Post tests of components which indicates that there is homogeneity of the group and thus post test score can be compared.

Table 4.6 Comparison between the Posttest Scores of ETCH-M in experimental and Control Group following CO-OP Intervention

Test	Outcome measure	Group	N	%	Mean Rank	Sum of Rank	U Score	Sig (2tailed)
Post test	**Word Legibility**	**Experimental**	17	86.56	18.76	319.00	123.00	0.441
		Control	17	84.59	16.24	276.00		
	Letter Legibility	**Experimental**	17	90.75	22.41	381.00	61.00	**0.004**
		Control	17	71.33	12.59	214.00		
	Numeral Legibility	**Experimental**	17	96.19	20.59	350.00	92.00	**0.051**
		Control	17	91.69	14.41	245.00		

Graph 4.4 Showing the comparison between the Posttest Scores of ETCH-M in Experimental and Control Group following CO-OP Intervention

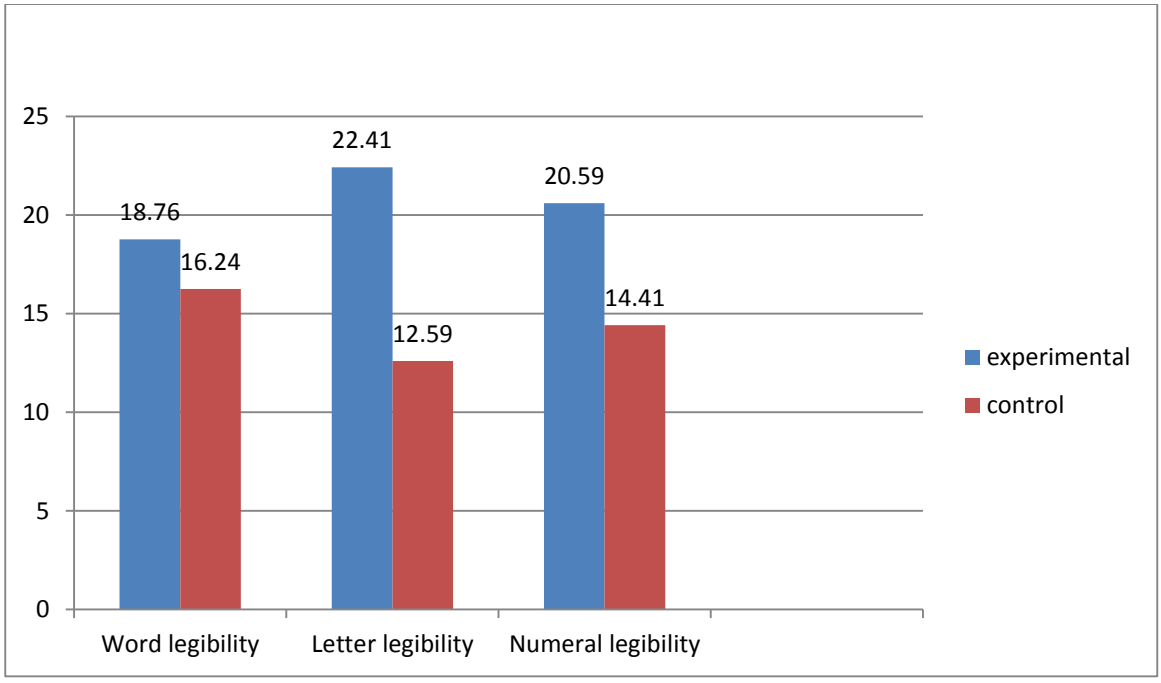


Table 4.6 & Graph 4.4: The above table shows between the group comparison of post test scores of ETCH-M components showing significant difference in the letter and numeral legibility but not in the word legibility component.

Table 5.1 Showing the Mean scores of PQRS of Experimental Group

Week	N	Minimum	Maximum	Mean	Std. Deviation
PQRS week 1	17	2	7	4.18	1.286
PQRS week 2	17	2	7	4.18	1.286
PQRS week 3	17	2	8	4.88	1.616
PQRS week 4	17	3	8	5.18	1.334
PQRS week 5	17	3	8	5.65	1.320
PQRS week 6	17	3	9	5.82	1.551
PQRS week 7	17	3	9	6.00	1.541
PQRS week 8	17	4	9	6.65	1.539
PQRS week 9	17	4	9	6.76	1.437
PQRS week 10	17	4	10	7.12	1.764
PQRS week 11	17	5	10	7.76	1.437
PQRS week 12	17	5	10	7.82	1.510

Graph 5.1 Showing the Mean Scores of PQRS of Experimental Group

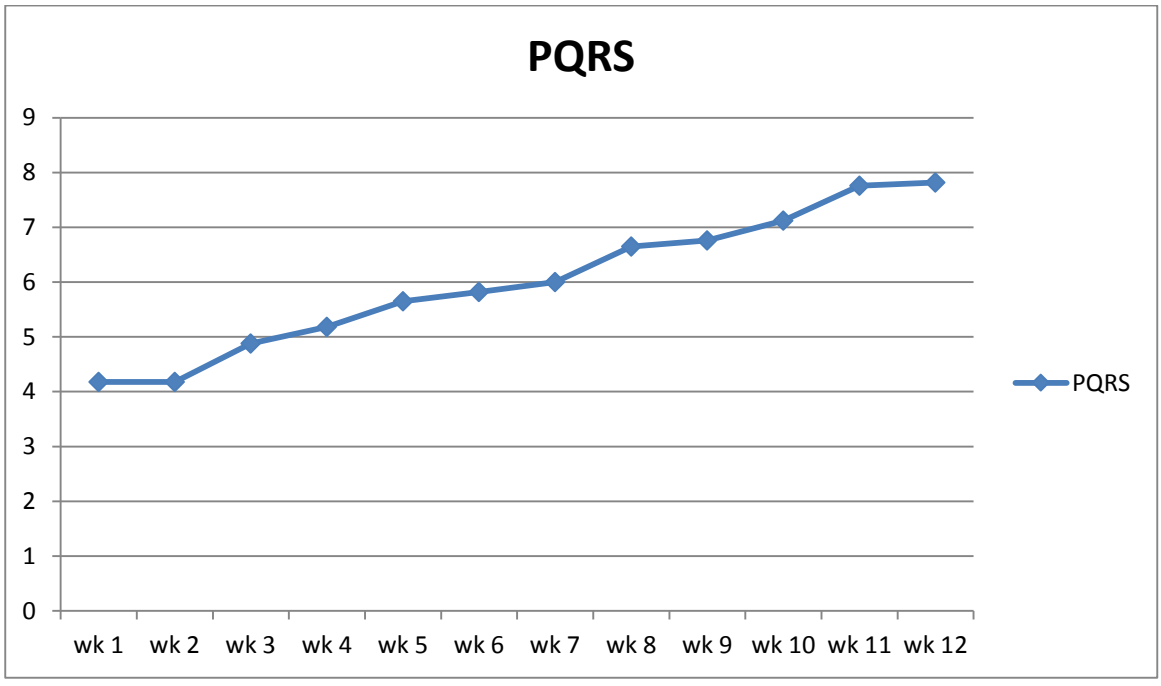


Table 5.1 & Graph 5.1: The above table shows the mean value of PQRS scores in the experimental group.

Table 5.2 Showing the Mean Scores of PQRS of Control Group

Week	N	Minimum	Maximum	Mean	Std. Deviation
PQRS week 1	17	1	4	2.00	.935
PQRS week 2	17	1	4	2.00	.935
PQRS week 3	17	1	4	2.00	.935
PQRS week 4	17	1	22	3.35	4.885
PQRS week 5	17	1	5	2.47	.943
PQRS week 6	17	2	5	2.94	.966
PQRS week 7	17	2	5	3.00	.935
PQRS week 8	17	2	5	3.12	.857
PQRS week 9	17	2	5	3.12	.857
PQRS week 10	17	2	5	3.18	.809
PQRS week 11	17	3	6	3.47	.874
PQRS week 12	17	3	6	3.82	.809

Graph 5.2 Showing the Mean Scores of PQRS of Control Group

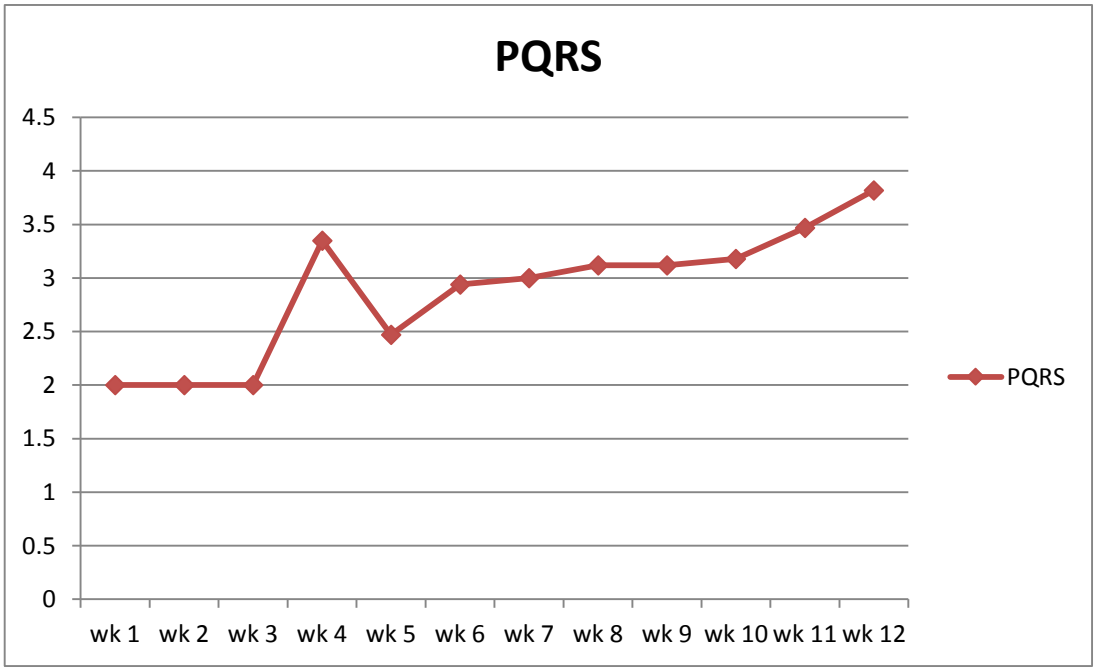


Table 5.2 & Graph 5.2: The above table shows the mean value of PQRS scores in the control group.

Table 5.3 Comparison of PQRS between Experimental and Control Group

Weeks	Group	N	Mean Rank	Sum of rank	U score	Sig(2tailed)
Week 1	Experimental	17	24.56	417.50	24.50	**0.00**
	Control	17	10.44	177.50		
Week 2	Experimental	17	24.56	417.50	24.50	**0.00**
	Control	17	10.44	177.50		
Week 3	Experimental	17	25.00	425.00	17.00	**0.00**
	Control	17	10.00	170.00		
Week 4	Experimental	17	24.53	417.00	25.00	**0.00**
	Control	17	10.47	178.00		
Week 5	Experimental	17	25.44	432.50	9.50	**0.00**
	Control	17	9.56	162.50		
Week 6	Experimental	17	25.03	425.50	16.50	**0.00**
	Control	17	9.97	169.50		
Week 7	Experimental	17	25.15	427.50	14.50	**0.00**
	Control	17	9.85	167.50		
Week 8	Experimental	17	25.59	435.00	7.00	**0.00**
	Control	17	9.41	160.00		
Week 9	Experimental	17	25.68	436.50	5.50	**0.00**
	Control	17	9.32	158.50		
Week 10	Experimental	17	25.68	436.50	5.50	**0.00**
	Control	17	9.32	158.50		
Week 11	Experimental	17	25.82	439.00	3.00	**0.00**
	Control	17	9.18	156.00		
Week 12	Experimental	17	25.82	439.00	3.00	**0.00**
	Control	17	9.18	156.00		

Graph 5.3 Showing Comparison of PQRS between Experimental and Control Group

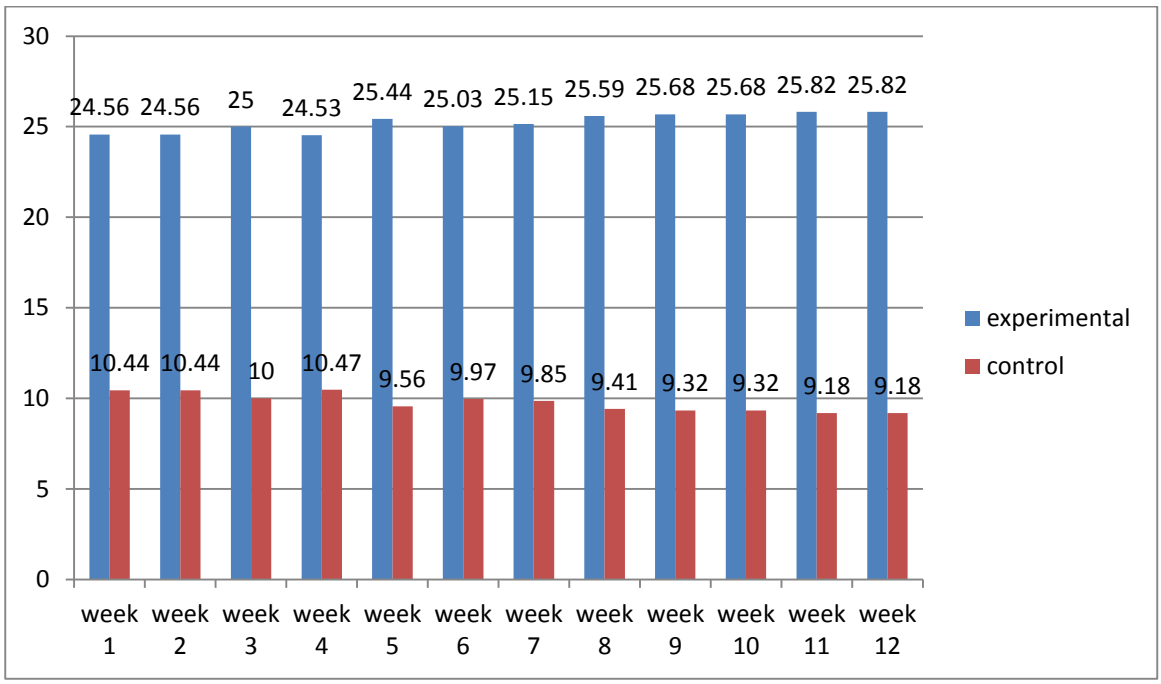


Table 5.3 & Graph 5.3: The above table shows between the group comparison of PQRS scores in all the 12 weeks of intervention showing significant difference in all the 12 weeks showing that the intervention given to the experimental group was highly effective.

RESULTS

***Participant characteristics*:**

All participants of the study were selected using DCDQ as the screening tool. 18 children were screened in total, for an indicative of DCD in the 8 years to 9 years 11 months age group and 16 children in the 10 years to 15 years age group. In total 34 children had an indicative of DCD (Table 1.1)

Children were allocated into control and experimental groups according to convenience sampling. The experimental group had 13 boys and 4 girls and the control group had 15 boys and 2 girls (Table 1.2)

Results of analysis of Canadian Occupational Performance Measure (COPM):

The experimental group shows a significant difference in performance (Z=2.59, p=.009) and satisfaction (Z=3.584 , p=0.000) components of COPM post intervention. This reveals that performance of the children have improved markedly in the experimental group post-test. The parents/teachers' satisfaction upon children's handwriting is markedly higher in the experimental group post-test (Table 2.2)

The control group showed no significant difference between in performance (Z=0.33, p=0.739) and satisfaction (Z=1.890, p=0.59) components of COPM post intervention.

At baseline there was a significant difference between experimental and control group in the performance component of COPM (U=84.50, p=0.033), but no significant difference in the satisfaction component (U=141.50, p=0.91).

Whereas on post test between the experimental and control group there was a significant difference both in the performance (U=40.50, p=0.00) and satisfaction component, (U=68.00, p=0.007) of COPM (Table 2.3). This reveals that there is marked improvement in the handwriting of the children in the experimental group when compared to the control group.

Results of analysis of Beery Buktenica scale of Visual Motor Integration, Visual Perception and Motor Coordination:

Analyses within the experimental group revealed that there was a significant difference in the components of Visual Motor Integration (Z=3.642, p=0.00, Visual Perception (Z=3.630, p=0.00) and Motor Coordination (Z=3.632, p=0.00) between pre-test and post-test scores. This reveals that there is marked improvement in all the three components of Beery Buktenica (VMI, VP, MC) post intervention (Table 3.3)

Analyses within the control group revealed that there was no significant difference in Visual Motor Integration (Z=1.380, p=0.168), Visual Perception (Z=1.265, p=0.206) and Motor Coordination (Z=2.384, p=0.17) from pre- to post-test (Table 3.4)

Whereas on post test between the experimental and control group there was a significant difference in Visual Motor Integration (U= 28.50, p=0.00), Visual Perception (U=58.50, p=0.00) and Motor Coordination (U=60.00, p=0.00). This reveals that the children in the experimental group improved markedly in VMI, VP and MC, post intervention (Table 3.5)

Results of analysis of Evaluation Tool of Children's Handwriting (ETCH) – Manuscript:

The experimental group revealed a significant difference in the components of word legibility (Z=2.324, p=0.020), letter legibility (Z=3.621, p=0.00) and numeral legibility (Z=2.441, p=0.015) from pre- to post-test. This reveals that there is marked improvement in all the three components of Evaluation Tool for Children's Handwriting – Manuscript (ETCH-M) post the intervention (Table 4.3)

There was a significant difference in the components of word legibility (Z=2.11, p=0.035), letter legibility (Z=2.779, p=0.005) but not in numeral legibility (Z=0.473, p=0.636) from pre-test to post-test (Table 4.4)

On between group comparison at pre-test revealed there was no significant difference in the components of word legibility (U=116.00, p=0.323), letter legibility (U=131.00, p=0.641) and numeral legibility (U=141.00, p=0.894). This shows that

both the experimental and control group were homogenous for comparison prior to the intervention (Table 4.5).

Whereas on post test between the experimental and control group there was a significant difference in the components of letter legibility (U=61.00, p=0.004), numeral legibility (U=92.00, p=0.051) but no significant difference in word legibility (U=123.00, p=0.441). This reveals that the children in the experimental group improved in letter and numeral legibility components compared to the word legibility component of ETCH-M, post intervention (Table 4.6)

Results of analysis of Performance Quality Rating Scale (PQRS):

Comparison between the experimental and control group scores of PQRS revealed that there is highly significant difference from week 1 to week 12 (U=24.50, 24.50, 17.00, 25.00, 9.50, 16.50, 14.50, 7.00, 5.50, 5.50, 3.00, 3.00, p=0.00 for 12 weeks). This reveals that there was a considerable increase in performance quality for the experimental group compared to the control group in all the 12 weeks of the intervention period (Table 5.3, Graph 6.3)

DISCUSSION

This research aimed to determine if CO-OP intervention approach facilitated improvements in handwriting performance in children with DCD. Consistent with the hypothesis, children who undertook the 12 week CO-OP intervention program experienced improvements in perceived performance and satisfaction, VMI, VP, MC and handwriting legibility as compared to the control group. Evidence suggests intervention protocols that make use of global problem solving training strategies are an effective way of remediating handwriting[14].

Improvement in performance and satisfaction of handwriting performance following CO-OP intervention:

Children in the CO-OP intervention group displayed significant changes in performance and satisfaction ratings on the COPM for the goals worked on during the intervention period post-treatment as perceived by the teachers, similarly these changes were also seen in the therapist's scoring for PQRS. This considerable increase in the post intervention assessment scores for COPM performance and satisfaction provides evidence that the children were able to achieve their chosen goals. This result is consistent with the study done by Mandich et al which says that CO-OP is an effective intervention for young children with DCD. Similar results was also obtained in a study done by Rodger et al which states that improvement in the performance and satisfaction component of COPM were the best indicators of reflecting goal achievement[12].

Thornton et al also found significant changes in the performance and satisfaction ratings on COPM which provides valuable information in terms of the child and parent perception of their improvement over the intervention period[24].

Effect of CO-OP approach on VMI, VP , MC skills:

The Beery Buktenica scale of Developmental test of Visual Motor Integration, Visual Perception and Motor Coordination was used to evaluate the precursors of handwriting. The skills of VMI, VP and MC also improved post CO-OP intervention. This is in contrast with the study done by Ward which says that VMI scores remained the same in the post test as the pre-test which can be attributed to the fact that the

children in this study received only 10 weeks of intervention unlike 12 weeks. And also due to the fact that they had other occupational goals also set by the children unlike purely focusing on handwriting. Whereas the children in the control group underwent only handwriting practice on a daily basis which may have had much impact on the underlying skills of visual motor integration, visual perception and motor coordination in children with DCD. Rather a properly planned cognitive based intervention only is of much benefit for these children.

When compared between the groups post intervention it was found that the COOP group showed improvements in the VMI, VP and MC skills. The percentage of word, letter and numeral legibility increased in the post-test. This indicates and confirms that CO-OP as a cognitive based intervention improves not only handwriting but the prerequisite skills. This result is consistent with the study done by Kaiser et al, which says that visual motor integration and eye hand coordination are predictive factors for improving the quality of handwriting[23].

Handwriting performance on ETCH-M:

Handwriting performance was evaluated using Evaluation Tool for Children's Handwriting – Manuscript (ETCH-M) as the outcome measure. The cursive component of this tool was not used as the children participated in this study were not taught cursive handwriting in their schools. Cursive handwriting is preceded by manuscript handwriting which in itself is difficult for children with DCD. Therefore schools focused on proper handwriting in the manuscript level even for the children as high as 5th graders.

The CO-OP group showed improvement in the percentage of word legibility from 72.98% to 86.56%, letter legibility from 67.43% to 90.75% and numeral legibility from 91.69% to 96.19%.Similarly the control group improved in the percentage of word legibility from 78,23% to 84.59%, letter legibility from 68.01 % to 71.33% and numeral legibility from 91.00% to 91.69%. The mean difference in WL, LL, and NL was more in the experimental group than in the control group. This findings are consistent with the finding of Banks, Rodger and Polatajko (2008) who found that the handwriting speed and word legibility raw scores were higher in the COOP group than in the control

group. This indicates that the children in the experimental group improved markedly in their handwriting performance specifically in printing letters and numerals separately but need some more time in showing significant difference in printing words legibly. This is also similar to the findings of the study done by Daftari which concludes that the children participated in the study improved in all aspects of ETCH test following CO-OP intervention.

This is significant indicator why a cognitive based intervention such as CO-OP is essential for children with DCD for improving handwriting performance. The global strategy of GOAL, PLAN, DO and CHECK can be easily executed by the children during their task performance. In addition to this, the Domain Specific Strategies (DSS), which includes body position, verbal mnemonic, verbal script, task specification and feeling the movement of the task can be easily learned and readily applied to the handwriting component of the occupational goal, making it easier for the children to have self-talk as they perform the task.

Effect of CO-OP approach on PQRS:

The Performance Quality Rating Scale was used to score the performance of each child on a weekly basis. It was done for all the 12 weeks of the intervention period. The mean scores of the experimental group show a very gradual and considerable in performance during CO=OP intervention [Table 5.1, Graph 5.1]. The control group demonstrated slight variations in fluctuating patterns of performance with a slight overall improvement improvement in their performance [Table 5.2, Graph 5.2]. During the 1st 3 weeks the control group showed no change in performance but after the researcher emphasized on the handwriting homework there was a sudden spike in performance in the 4th week and thereafter a gradual increase in performance of their chosen goals for handwriting improvement This shows that the performance of the children in the experimental group was better than the control group. These results are similar to the results of the study done by **Taylor et al** which says the improvement in the scores of PQRS indicates that there is improvement in the performance of the chosen goals using the CO-OP intervention[27].

The CO-OP intervention group demonstrated significant changes during post test. This highlights the ability of the children to participate actively in discussions regarding the development of plans. Since the age of the children ranged from 8 to 11 years they should have been able to set goals for themselves, but many of the children with DCD had difficulty in planning the goals therefore the researcher had to help the children in setting the goals . The children were able to perform better in their respective individual goals set by them. The children were also able to apply the learned skills in their classroom setting, which showed success in the transference of the learned skill. This confirmed that a cognitive based intervention is beneficial for children with DCD.

Whereas children in the control group were not able to show significant changes in the post test. This can be attributed to the fact of irregularity of homework completion which fails to give the children regular handwriting practice. Another important fact is that the motor incoordination was not addressed in these children through cognitive orientation towards the task at hand, like the children in the CO-OP intervention group. This was the major factor lacked by the children in the control group due to which the minor improvements observed in the post-test results were not as good as that of the post test results of the experimental group.

CONCLUSION

Therefore it can be suggested that CO-OP intervention will improve handwriting performance and help to learn effective strategies that can be used to develop additional skills like VMI, VP, MC in children with DCD.

LIMITATIONS AND RECOMMENDATIONS

LIMITATIONS

The attention span of the children was not consistent for the entire one hour of intervention.

Children in the control group were irregular in homework. A daily log could have been used to countercheck their homework along with a reward to reinforce their performance.

RECOMMENDATIONS

Further investigation is essential to find out the effectiveness of CO-OP approach on other components of occupational performance.

Minor adaptations can be done in the period of intervention such as reducing the length of each session and increasing the number of sessions.

Follow up is essential to ensure generalisation of the learned skills.

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DEVELOPMENTAL CO-ORDINATION DISORDER QUESTIONNAIRE

COORDINATION QUESTIONNAIRE (Revised 2007)

			Year	Mon	Day
Name of Child:	_____	**Today's Date:**			
Person completing Questionnaire:	_____	**Child's Birth:**			
Relationship to child:	_____	**Child's Age:**			

Most of the motor skills that this questionnaire asks about are things that your child does with his or her hands, or when moving.
A child's coordination may improve each year as they grow and develop. For this reason, it will be easier for you to answer the questions if you think about other children that you know who *are the same age as your child*.
Please compare the degree of coordination your child has with other children of the same age when answering the questions.
Circle the one number that best describes your child. If you change your answer and want to circle another number, please circle the correct response twice.
If you are unclear about the meaning of a question, or about how you would answer a question to best describe your child, please call_____ at _____ for assistance.

	Not at all like your child	**A bit like your child**	**Moderately like your child**	**Quite a bit like your child**	**Extremely like your child**
	1	**2**	**3**	**4**	**5**
1.	Your child *throws a ball* in a controlled and accurate fashion.	1	2	3	4	5
2.	Your child *catches* a small *ball* (e.g., tennis ball size) thrown from a distance of 6 to 8 feet (1.8 to 2.4 meters).	1	2	3	4	5
3.	Your child *hits* an approaching *ball* or *birdie* with a bat or racquet accurately.	1	2	3	4	5
4.	Your child *jumps* easily *over* obstacles found in garden or play environment.	1	2	3	4	5
5.	Your child *runs* as fast and in a *similar* way to other children of the same gender and age.	1	2	3	4	5
6.	If your child has a *plan* to do a motor *activity*, he/she can organize his/her body to follow the plan and effectively complete the task (e.g., building a cardboard or cushion "fort," moving on playground equipment, building a house or a structure with blocks, or using craft materials).	1	2	3	4	5

(OVER)

	Not at all like your child 1	A bit like your child 2	Moderately like your child 3	Quite a bit like your child 4	Extremely like your child 5

7. Your child's printing or *writing* or drawing in class is *fast* enough to keep up with the rest of the children in the class.

1 2 3 4 5

8. Your child's printing or *writing* letters, numbers and words is *legible*, precise and accurate or, if your child is not yet printing, he or she *colors and draws* in a coordinated way and makes pictures that you can recognize.

1 2 3 4 5

9. Your child uses appropriate *effort* or tension when printing or writing or drawing (no excessive *pressure* or tightness of grasp on the pencil, writing is not too heavy or dark, or too light).

1 2 3 4 5

10. Your child *cuts* out pictures and *shapes* accurately and easily.

1 2 3 4 5

11. Your child is interested in and *likes* participating in *sports or active* games requiring good motor skills.

1 2 3 4 5

12. Your child learns *new motor tasks* (e.g., swimming, rollerblading) easily and does not require more practice or time than other children to achieve the same level of skill.

1 2 3 4 5

13. Your child is *quick and competent* in tidying up, putting on shoes, tying shoes, dressing, etc.

1 2 3 4 5

14. Your child would ***never*** be described as a *"bull in a china shop"* (that is, appears so clumsy that he or she might break fragile things in a small room).

1 2 3 4 5

15. Your child does ***not*** *fatigue easily* or appear to slouch and "fall out" of the chair if required to sit for long periods.

1 2 3 4 5

Thank you.

Coordination Questionnaire (DCDQ'07): Score Sheet

Name: _____ **Date:** _____

Birth Date: _____ **Age:** _____

	Control During Movement	Fine Motor/ Handwriting	General Coordination
1. Throws ball			
2. Catches ball			
3. Hits ball/birdie			
4. Jumps over			
5. Runs			
6. Plans activity			
7. Writing fast			
8. Writing legibly			
9. Effort and pressure			
10. Cuts			
11. Likes sports			
12. Learning new skills			
13. Quick and competent			
14 "Bull in shop"			
15. Does not fatigue			

TOTAL _____ / 30 Control during Movement + _____ / 20 Fine Motor/ Handwriting + _____ / 25 General Coordination = _____ / 75 **TOTAL**

For Children Ages 5 years 0 months to 7 years 11 months
- 15-46 indication of DCD or suspect DCD
- 47-75 probably not DCD

For Children Ages 8 years 0 months to 9 years 11 months
- 15-55 indication of DCD or suspect DCD
- 56-75 probably not DCD

For Children Ages 10 years 0 months to 15 years
- 15-57 indication of DCD or suspect DCD
- 58-75 probably not DCD

CANADIAN OCCUPATIONAL PERFORMANCE MEASURE

CANADIAN OCCUPATIONAL PERFORMANCE MEASURE

Authors:
Mary Law, Sue Baptiste, Anne Carswell,
Mary Ann McColl, Helene Polatajko, Nancy Pollock

The Canadian Occupational Performance Measure (COPM) is an individualized measure designed for use by occupational therapists to detect self-perceived change in occupational performance problems over time.

Client Name:		
Age:	Gender:	ID#:
Respondent (if not client):		
Date of Assessment:	Planned Date of Reassessment:	Date of Reassessment:

Therapist:
Facility/Agency:
Program:

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STEP 1:
IDENTIFICATION OF OCCUPATIONAL PERFORMANCE ISSUES

To identify occupational performance problems, concerns and issues, interview the client, asking about daily activities in self-care, productivity and leisure. Ask clients to identify daily activities which they want to do, need to do or are expected to do by encouraging them to think about a typical day. Then ask the client to identify which of these activities are difficult for them to do now to their satisfaction. Record these activity problems in Steps 1A, 1B, or 1C.

STEP 2:
RATING IMPORTANCE

Using the scoring card provided, ask the client to rate, on a scale of 1 to 10, the importance of each activity. Place the ratings in the corresponding boxes in Steps 1A, 1B, or 1C.

STEP 1A: Self-care

IMPORTANCE

Personal Care
(e.g., dressing, bathing, feeding, hygiene)

_____ ☐
_____ ☐
_____ ☐

Functional Mobility
(e.g., transfers, indoor, outdoor)

_____ ☐
_____ ☐
_____ ☐

Community Management
(e.g., transportation, shopping, finances)

_____ ☐
_____ ☐
_____ ☐

STEP 1B: Productivity

Paid/Unpaid Work
(e.g., finding/keeping a job, volunteering)

_____ ☐
_____ ☐
_____ ☐

Household Management
(e.g., cleaning, laundry, cooking)

_____ ☐
_____ ☐
_____ ☐

Play/School
(e.g., play skills, homework)

_____ ☐
_____ ☐
_____ ☐

STEP 1C: Leisure

		IMPORTANCE
Quiet Recreation (e.g., hobbies, crafts, reading)		
Active Recreation (e.g., sports, outings, travel)		
Socialization (e.g., visiting, phone calls, parties, correspondence)		

STEPS 3 & 4: SCORING - INITIAL ASSESSMENT and REASSESSMENT

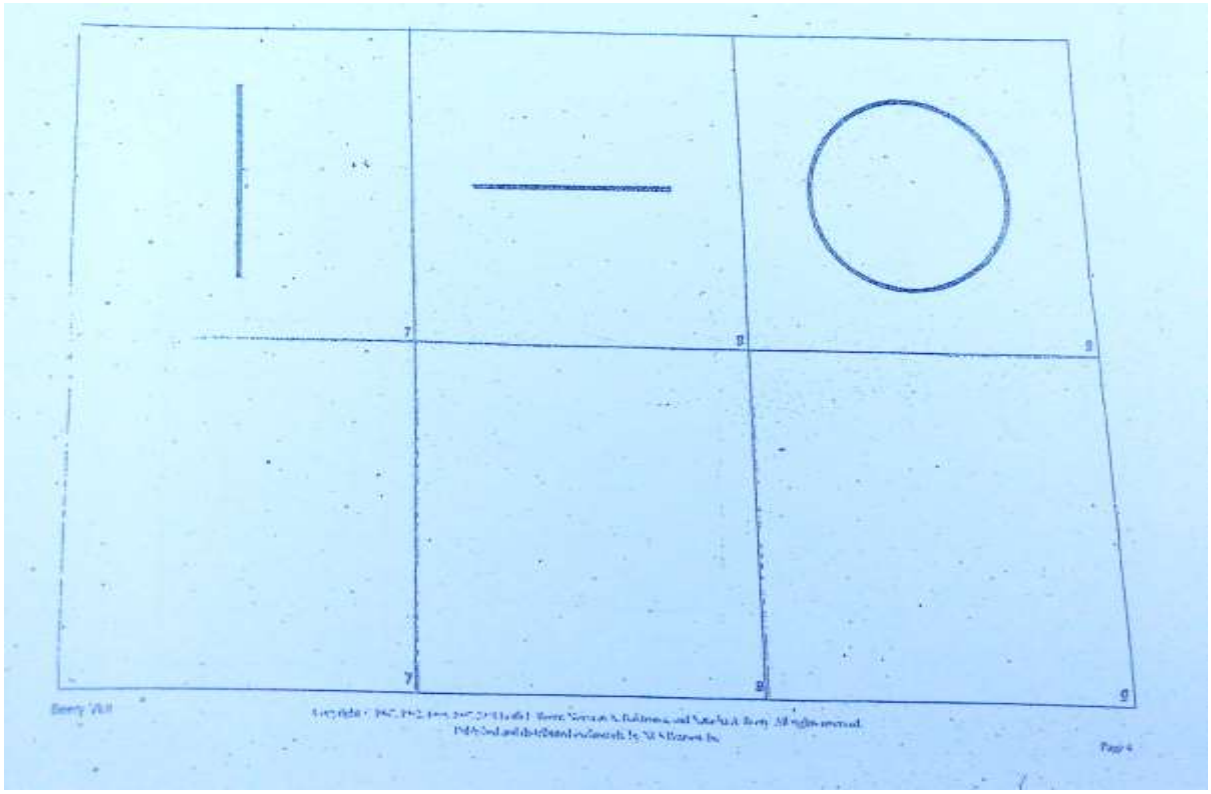
Confirm with the client the 5 most important problems and record them below. Using the scoring cards, ask the client to rate each problem on performance and satisfaction, then calculate the total scores. Total scores are calculated by adding together the performance or satisfaction scores for all problems and dividing by the number of problems. At reassessment, the client scores each problem again for performance and satisfaction. Calculate the new scores and the change score.

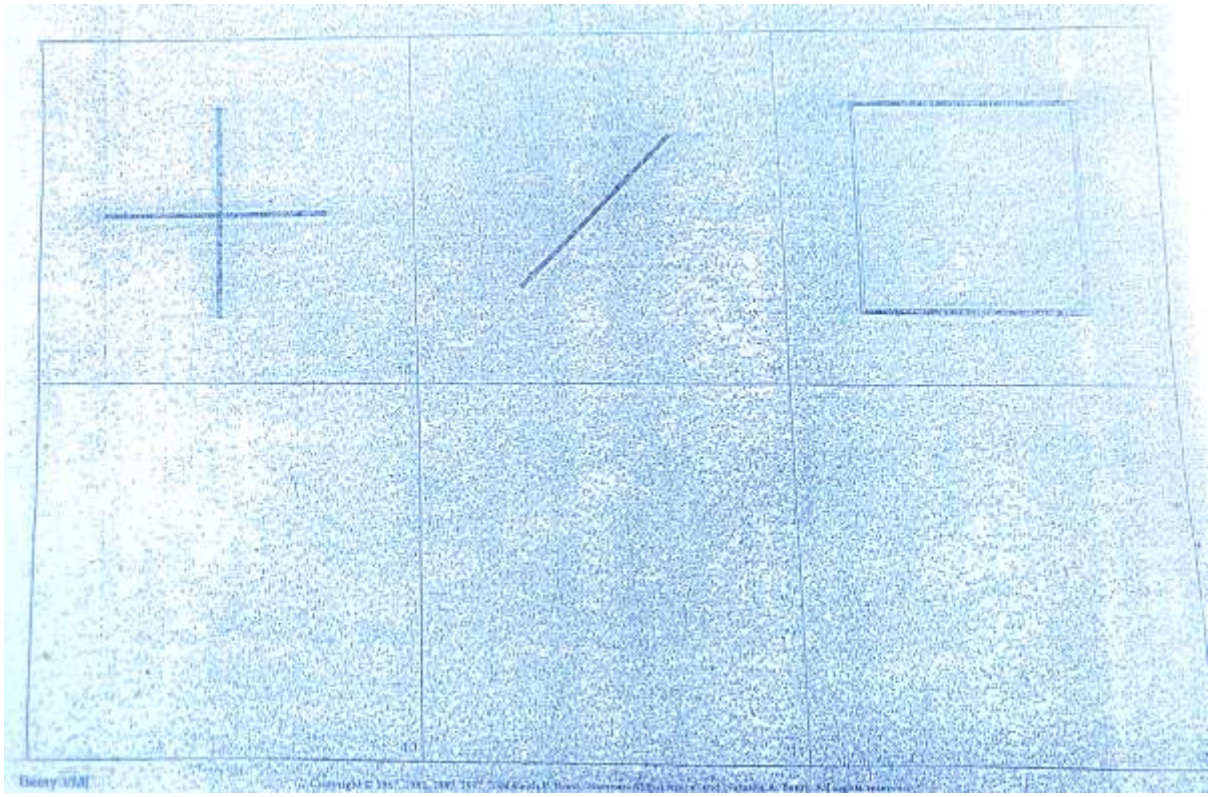
Initial Assessment:			**Reassessment:**	
OCCUPATIONAL PERFORMANCE PROBLEMS:	PERFORMANCE 1	SATISFACTION 1	PERFORMANCE 2	SATISFACTION 2
1.				
2.				
3.				
4.				
5.				
SCORING:	PERFORMANCE SCORE 1	SATISFACTION SCORE 1	PERFORMANCE SCORE 2	SATISFACTION SCORE 2
Total score = Total performance or satisfaction scores / # of problems	/ =	/ =	/ =	/ =

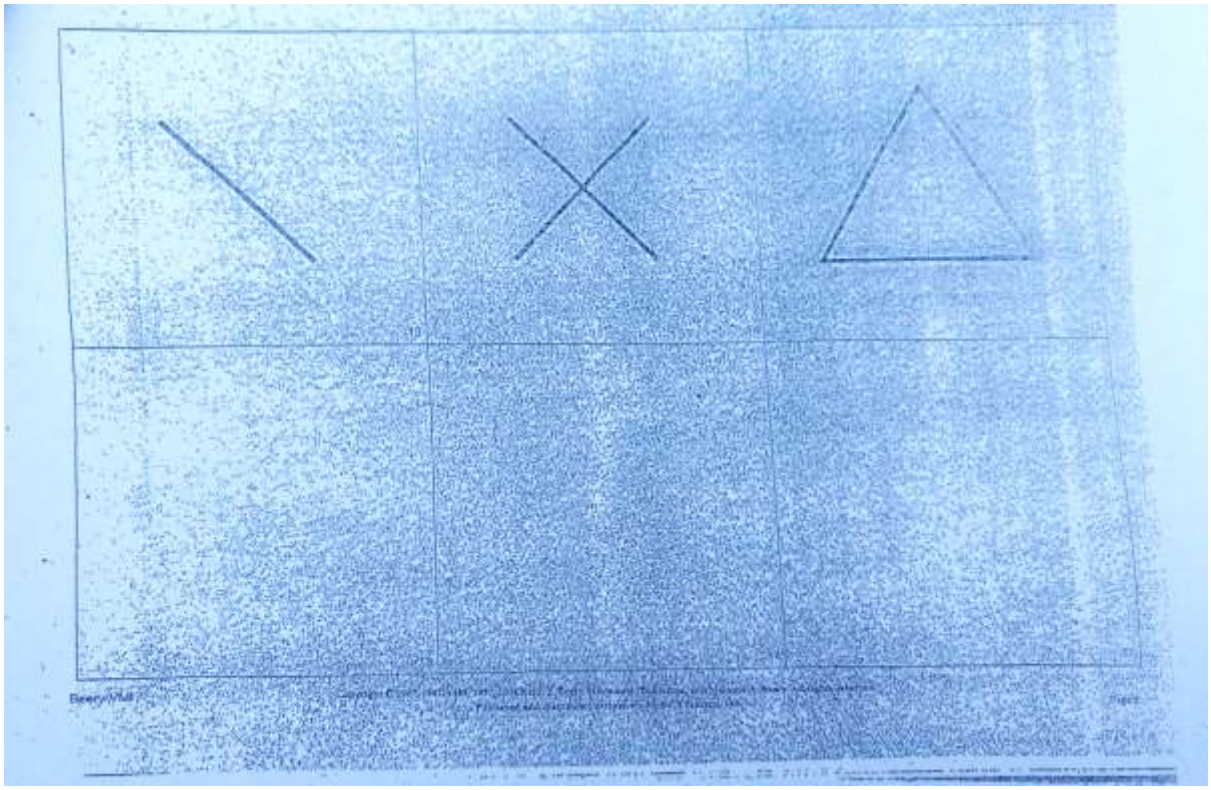
CHANGE IN PERFORMANCE = Performance Score 2 [ ] − Performance Score 1 [ ] = [ ]

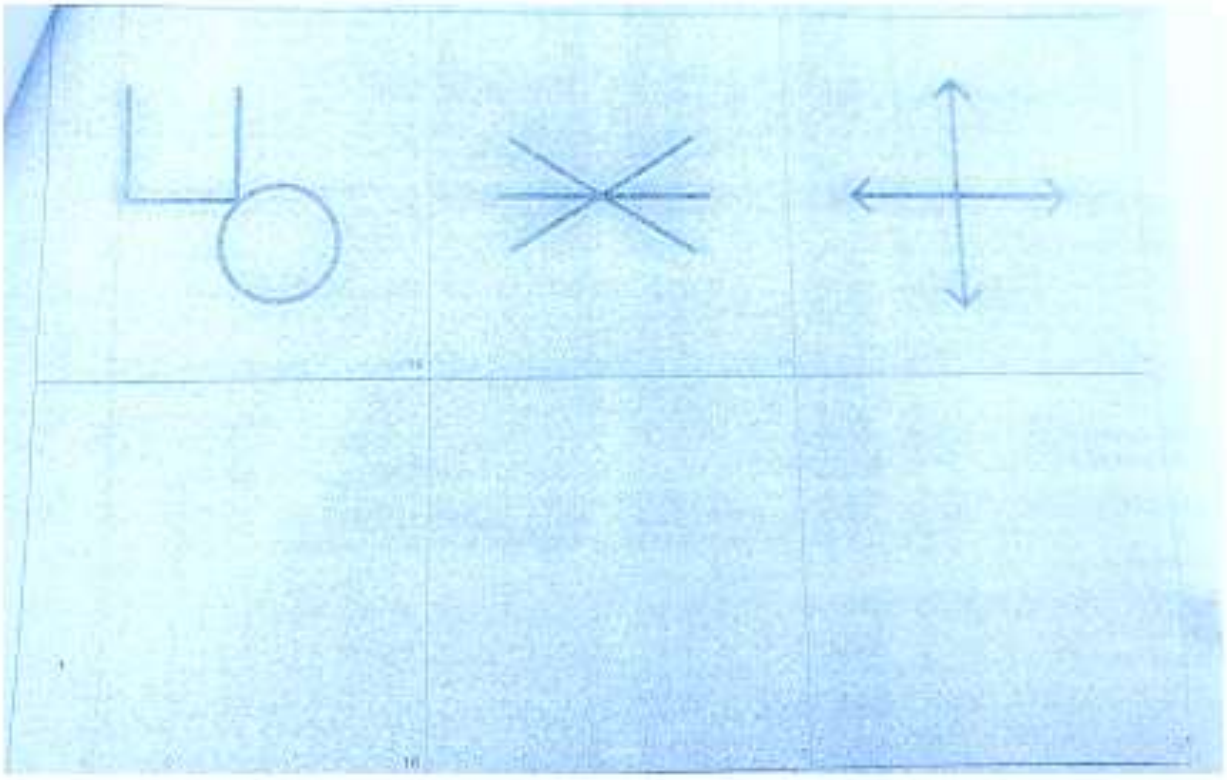
CHANGE IN SATISFACTION = Satisfaction Score 2 [ ] − Satisfaction Score 1 [ ] = [ ]

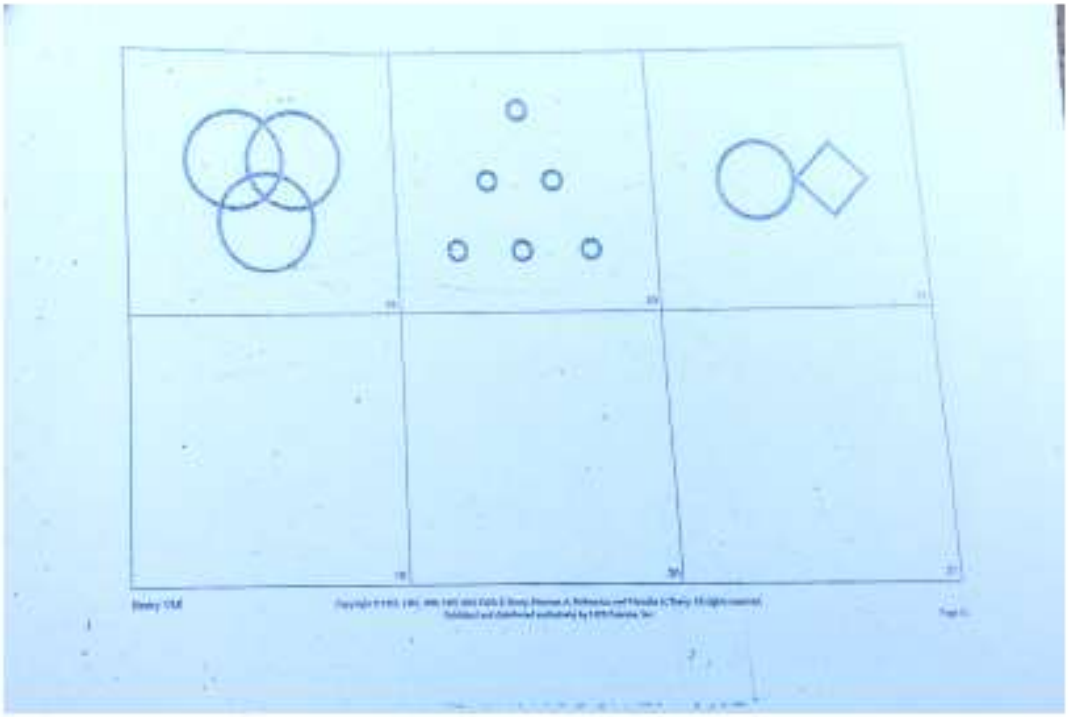
BEERY BUKTENICA SCALE OF VISUAL MOTOR INTEGRATION

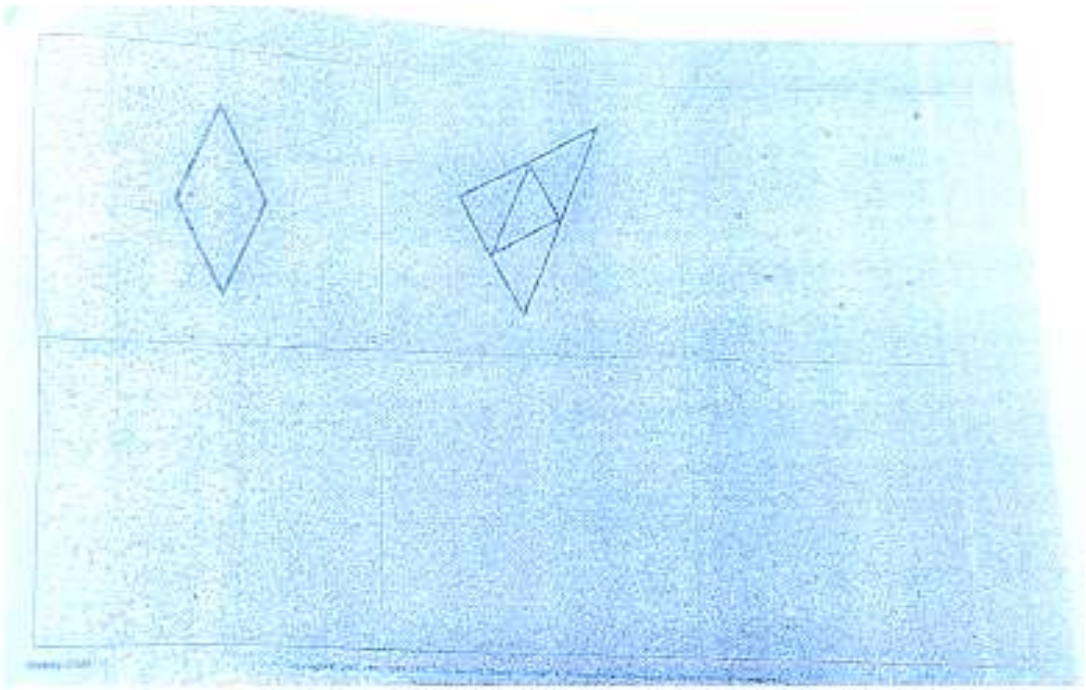


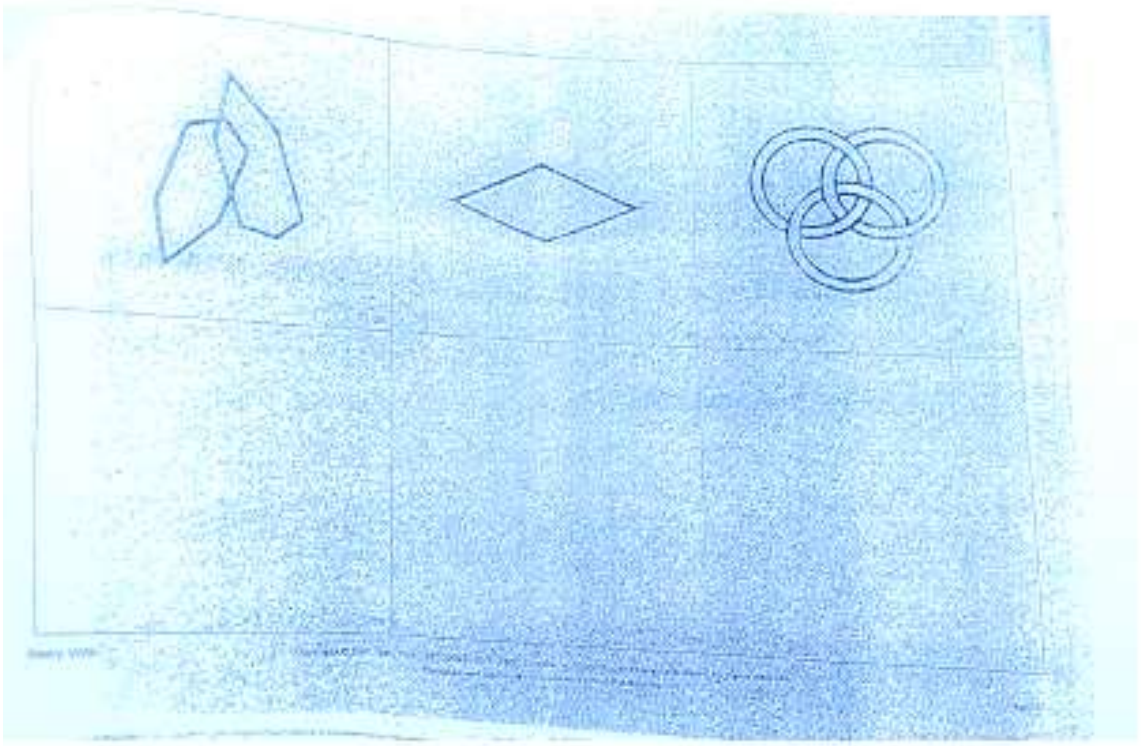


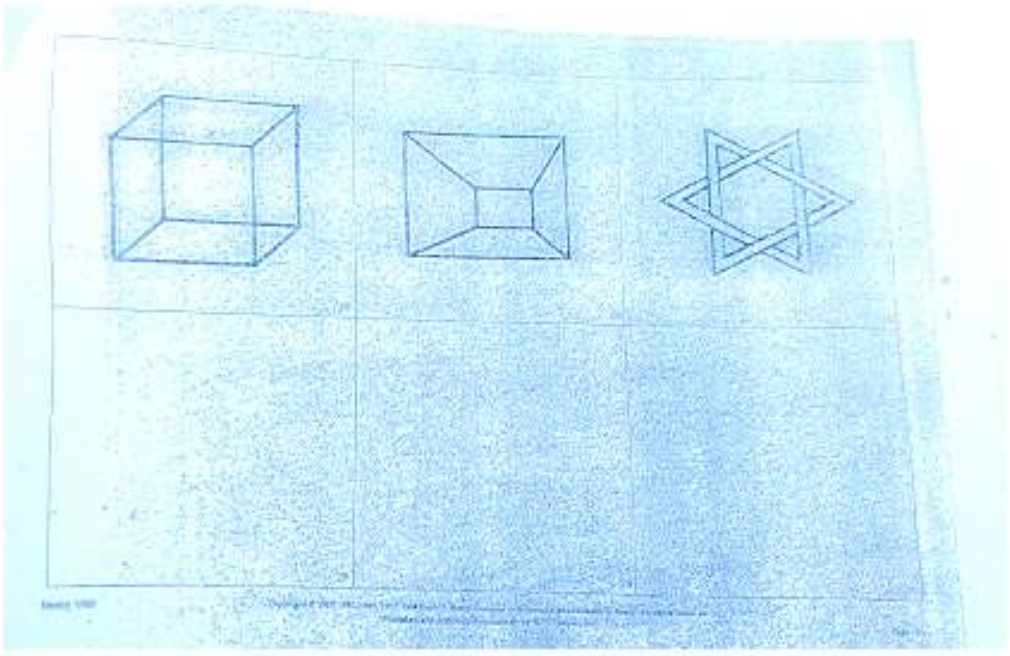




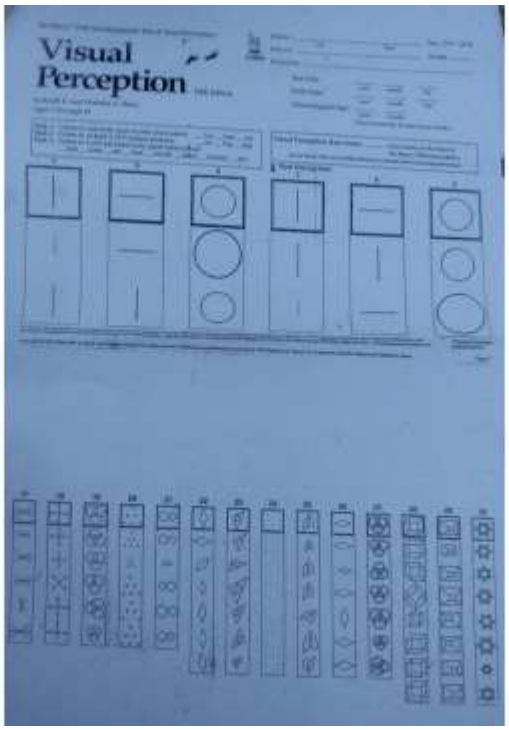


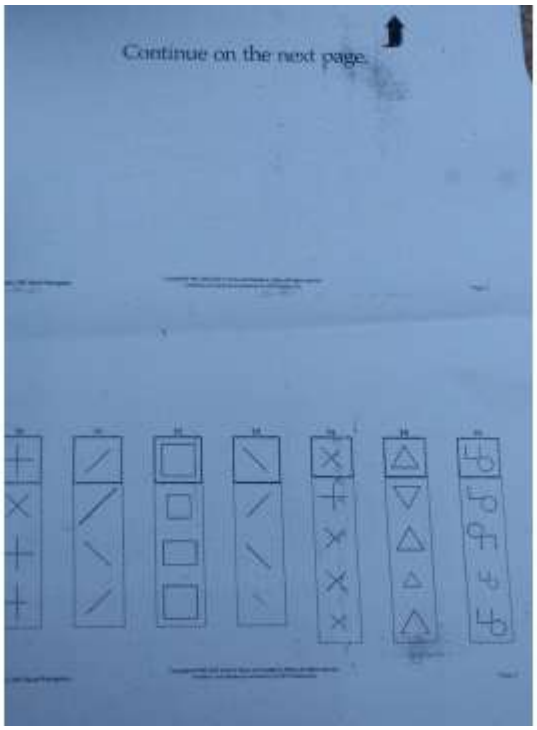




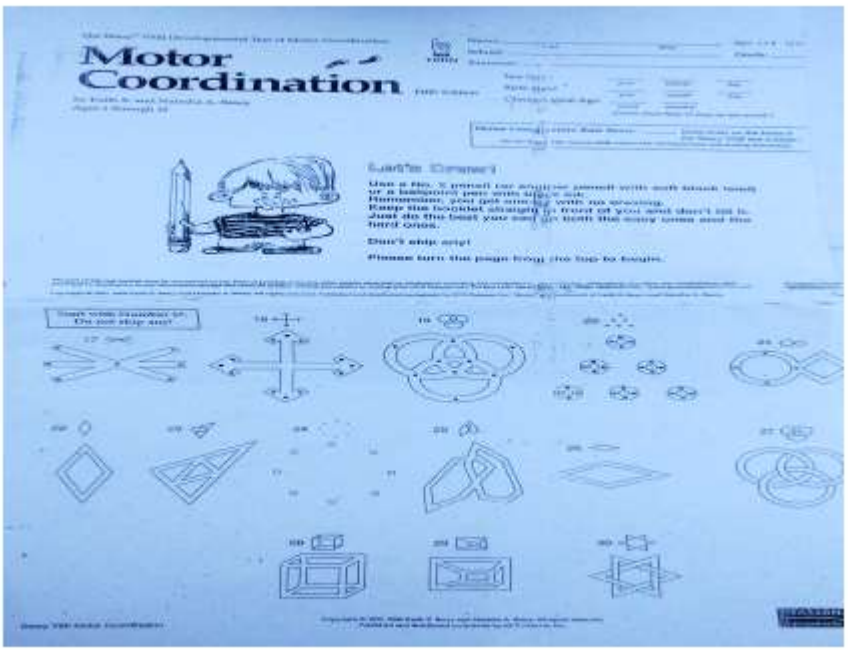


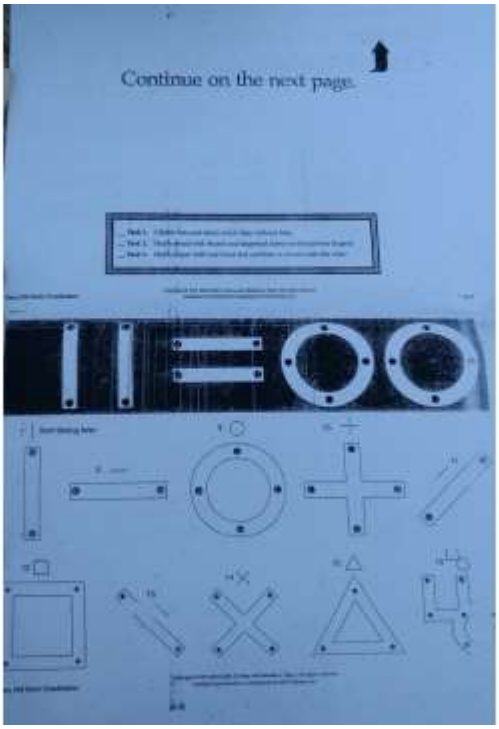
VISUAL PERCEPTION





MOTOR COORDINATION





EVALUATION TOOL FOR CHILDREN'S HANDWRITING – MANUSCRIPT

MANUSCRIPT

Evaluation Tool of Children's Handwriting

Response Booklet

Name _____

I. Alphabet Writing

Lower-Case Letters

Upper-Case Letters

II. Numeral Writing

MANUSCRIPT

ETCH Response Booklet

III. Near-Point Copying

IV. Far-Point Copying

V. Dictation

VI. Sentence Composition

MANUSCRIPT

Evaluation Tool of Children's Handwriting

Score Sheet

Child's Name: _____ Date of Evaluation: YR _____ MO _____ DA _____

Child's Grade: _____ Date of Birth: _____

Examiner's Name: _____ Chronological Age: _____

KEY

OMIT = omitted | ILLEG = illegible | LF = letter formation | AL = horizontal alignment

UNAQ = unaquired | CASE = letter case | SZ = size | SP = spacing

I. ALPHABET WRITING

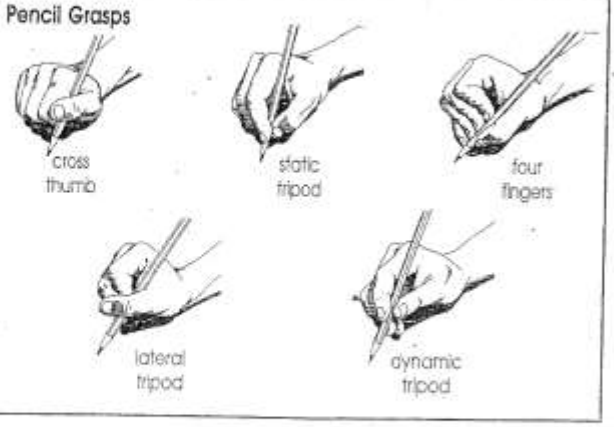
A. Lower-Case Letters

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	SUBTOTALS	
OMIT/UNAQ																												ILLEG TOTAL
ILLEGIBLE																												
LF																											LEGIBLE [26- =]	
SZ																											*LETTER LEGIBILITY %*	
AL																												
SP																												
CASE																											TIME:	

B. Upper-Case Letters

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	SUBTOTALS	
OMIT/UNAQ																												ILLEG TOTAL
ILLEGIBLE																												
LF																											LEGIBLE [26- =]	
SZ																											*LETTER LEGIBILITY %*	
AL																												
SP																												
CASE																											TIME:	

Pencil Grasps



Hand Preference

Left Right Mixed

Grasp Descriptors

Web Space

Open Elliptical Closed

Thumb Placement

Opposed Over Under

Finger Positions

Mid-Range Extended Flexed

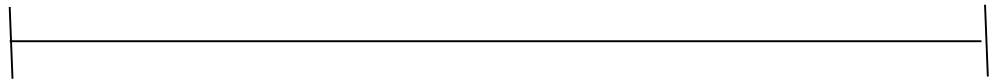
MANUSCRIPT

ETCH Score Sheet

PENCIL MANAGEMENT				COMMENTS
Continual Writing Movement	Fluent	Irregular	Dysfluent	
Positional Consistency of Pencil	Consistent	Inconsistent		
Positional Consistency of Paper	Consistent	Inconsistent		
Pencil Pressure	Suitable	Heavy	Light	
Manipulating Pencil In Hand				
Translation	Complete	Partial	None	
Shift	Complete	Partial	None	
Simple Rotation	Complete	Partial	None	
Complex Rotation	Complete	Partial	None	

CLASSROOM OBSERVATIONS

PERFORMANCE QUALITY RATING SCALE



1 10

PARENT CONSENT FORM

I Mrs/Mr/Ms._____ parent/guardian of child _____, give my consent to become a participant in the research study: **"Effectiveness of Cognitive Orientation to Occupational Performance in children with Developmental Coordination Disorder".** The researcher has explained me the content of her research, the aspects where she needs my involvement, what treatment program she is providing and has answered the questions related to the research to my satisfaction.

Date:

Signature of the Parent/Guardian Signature of the Researcher

PARENT CONSENT FORM

I Mrs/Mr/Ms._____ parent/guardian of child _____, give my consent to become a participant in the research study: **"Effectiveness of Cognitive Orientation to Occupational Performance in children with Developmental Coordination Disorder".** The researcher has explained me the content of her research, the aspects where she needs my involvement, what treatment program she is providing and has answered the questions related to the research to my satisfaction.

Date:

Signature of the Parent/Guardian Signature of the Researcher

ETHICAL CLEARANCE

KMCH ETHICS COMMITTEE
KOVAI MEDICAL CENTER AND HOSPITAL LIMITED
Post Box No. 3209, Avanashi Road, Coimbatore - 641 014. INDIA
✆ : (0422) 4323800, 4323619 Fax : (0422) 4270805
E-mail : ethics@kmchhospitals.com
EC Reg. No : ECR / 112 / Inst / TN / 2013

APPROVED

Ref: EC/AP/548/07/2017
24.07.2017

To

Dr. K. Rajendran,
Head of the Department – Pediatrics and Neonatalogy,
Kovai Medical Center and Hospital,
Coimbatore-641 014,
Tamilnadu, India.

Dear Dr. K. Rajendran.

The proposal entitled **"Effetiveness of Cognitive Orientation to Occupational Perfomance (CO – OP) to improve Handwriting Performance in Children with developmental Co – Ordination Disorder (DCD)"** submitted by **Ms. Blessy Olive Johnson** under your supervision was reviewed by the Ethics Committee in its meeting held on **22.07.2017** and permission is granted to carry out the study at **Kovai Medical Center and Hospital Ltd, Coimbatore, India.**

Thanking you,

Yours faithfully,

Dr. P. R. Muthuswamy
Chairman, KMCH Ethics Committee

Dr. P. R. MUTHUSWAMY,
MA.,MBA. FDPM(IIM-A)Ph.D.,
Chairman
Ethics Committee
Kovai Medical Center and Hospital
Avanashi Road,
COIMBATORE-641 014.

KMCH ETHICS COMMITTEE
KOVAI MEDICAL CENTER AND HOSPITAL LIMITED

Post Box No. 3209, Avanashi Road, Coimbatore - 641 014. INDIA
✆ : (0422) 4323800, 4323619 Fax : (0422) 4270805
E-mail : ethics@kmchhospitals.com
EC Reg. No : ECR / 112 / Inst / TN / 2013

KMCH ETHICS COMMITTEE MEMBERS LIST

S. NO	MEMBER NAME	DESIGNATION	REPRESENTATION	DESIGNATION TO THE INSTITUTION	GENDER
1.	Dr.P.R.Muthuswamy	Principal, Dr.N.G.P Arts & Science College	Chairperson	Chairperson, KMCH Ethics Committee	M
2	Dr. Devdas Madhavan	Consultant Urologist	Member Secretary	Consultant Urologist	M
3	Dr. V.Rajamani	Consultant Rheumatologist & Physician	Clinician	Consultant Rheumatologist & Physician	M
4	Dr.K.Senthilkumar	MD-Pharmacology Pharmacologist	Basic Medical Scientist	None	M
5	Dr. A.N.Murugan	Medical Director	Clinician	Medical Director	M
6	Dr. Sangita S.Mehta	Consultant Pathologist	Clinician	Consultant Pathologist	F
7	Dr. S.Madhavi	Principal	Member	Principal, KMCH college of Nursing	F
8	Dr. K.S.G.Arul Kumaran	Professor	Basic Medical Scientist	Professor, KMCH college of Pharmacy	M
9	Dr. S.Thamil Selvi	Social Worker	Social worker	None	F
10	Mr. C.Tamil Selvan	VP-Materials	convener	VP-Materials	M
11	Mr. T.C.Dinamani	Advocate	Legal Expert	Personnel Manager	M
12	Mr.R.Krishnamoorthy	Priest	Theologist	Priest	M
13	Mr. D.Ramanathan	Office Assistant	Lay person	Office Assistant	M

Dr. P. R. Muthuswamy 22/7/13
Chairman, Ethics Committee

Dr. P. R. MUTHUSWAMY,
MA.,MBA..FDPM(IIM-A)Ph.D.,
Chairman
Ethics Committee
Kovai Medical Center and Hospital
Avanashi Road,
COIMBATORE-641 014

PERMISSION LETTER – RASHMIKA SCHOOL

Rashmika

Rashmika Centre for Learning & Counselling

(Run with the Technical Assistance of Madras Dyslexia Association)
No : 14, Gandhi Nagar, Near Indian Overseas Bank,
Nanjundapuram Road, Coimbatore - 641 036.

Mrs: Elizabeth Suresh 5th July 17

To
Dr. Sujatha Missal,
Head of the O.T Dept
KMCH
Coimbatore

Dear Dr. Sujatha,

Greetings! We are very happy to have Miss Blessy Olive Johnson to do her project in our Centre. She has been given permission to do the same on every wednesday afternoon till she finishes the collection of Data.

Yours sincerely

Rashmika Centre for Learning & Counselling

Rashmika

Rashmika Centre for Learning & Counselling
(Run with the Technical Assistance of Madras Dyslexia Association)
No : 14, Gandhi Nagar, Near Indian Overseas Bank,
Nanjundapuram Road, Coimbatore - 641 036.

To Whomsoever It May Concern.

This is to certify that Miss: Blessy Olive Johnson, MOT IInd year, KMCH college of Occupational Therapy. Conducted her study on "Effectiveness of Cognitive Orientation to Occupational Performance [Co-OP] to improve Handwriting Performance in children with Developmental Co-ordination Disorder." in our Organization.

Rashmika
Centre for Learning & Counselling
(Run with the Technical Assistance of Madras Dyslexia Association)
No : 14, Gandhi Nagar, Near Indian Overseas Bank,
Nanjundapuram Road, Coimbatore - 641 036.

PRINCIPAL / CORRESPONENT

PERMISSION LETTER – COGNITO SCHOOL

Dr. N. Lakshmanan M.A., M.Phil., PhD.,
Director and Clinical Psychologist

Cognito ACADEMY FOR LEARNING ACHIEVEMENT

TO

22nd June 2017

Dr. Sujatha Missal

Principal

KMCH College of Occupational Therapy

Coimbatore

Respected Ma'am,

Greetings! We are happy to have Miss. Blessy Olive Johnson to do her project in our centre upon the topic, "Effectiveness of Cognitive Orientation to Occupational Performance (CO-OP) to improve handwriting performance in children with Developmental Coordination Disorder (DCD)". She has been given permission to do the same on every Monday and Thursday till she finishes the collection of data.

Yours Sincerely,

MADHU HARI CHARITABLE TRUST | Regd. No. 485/BK4/2009
15, 2nd Street, Tatabad, Sivananda Colony, Opp. Wellington Apartment, Coimbatore - 641 012.
Contact : 98420 06144, 99429 06144. | E-Mail : cognitokovai@gmail.com

Cognito ACADEMY FOR LEARNING ACHIEVEMENT
கற்க கசடறa...

Dr. N. Lakshmanan M.A., M.Phil., PhD.,
Director and Clinical Psychologist

28.08.2017

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ms. Blessy Olive Johnson**, MOT IInd year, KMCH College of Occupational Therapy conducted her study on " **Effectiveness of Cognitive Orientation to Occupational Performance (CO-OP) to Improve Hand Writing Performance in Children with Developmental Co-ordination Disorder"** in our organization.

Dr.N.LAKSHMANAN.M.A.,MPHIL (M&SP).,PhD.,
CONSULTANT CLINICAL PSYCHOLOGIST
RCI.Reg.No:A-25341

MASTER CHART

E_gender	E_age	DCDQ_8_9	DCDQ_10	E_copm_per	E_copm_sa	E_vmi_RS	E_vmi_SS	E_vp_RS	E_vp_SS	E_mc_RS	E_mc_SS	E_etch_WL	E_etch_LL	E_etch_NL	E_pqrs_wk_1	E_pqrs_wk_2	E_pqrs_wk_3	E_pqrs_wk_4	E_pqrs_wk_5	E_pqrs_wk_6	E_pqrs_wk_7	E_pqrs_wk_8	E_pqrs_wk_9	E_pqrs_w_10	E_pqrs_w_11	E_pqrs_w_12	Ep_copm_pr	Ep_copm_st	Ep_vmi_RS	Ep_vmi_SS	Ep_vp_RS	Ep_vp_SS	Ep_mc_RS	Ep_mc_SS	Ep_etch_WL	Ep_etch_LL	Ep_etch_NL
1	8.07	42	0	2	2	13	65	15	65	16	75	50.00	36.73	70.58	4	4	4	5	5	5	5	6	6	6	7	7	3	3	14	70	16	70	17	80	66.66	72.44	82.35
2	8.05	45	0	3	2	12	60	8	0	8	0	66.66	46.90	94.10	3	3	3	4	4	4	4	5	5	5	6	6	3	3	13	65	10	45	10	45	83.33	76.12	94.11
2	8.07	37	0	3	1	13	65	7	0	7	0	50.00	36.73	70.58	3	3	3	4	4	4	5	5	5	5	6	6	5	3	15	74	10	45	10	45	66.66	76.53	82.35
2	8.04	39	0	3	1	13	65	9	0	13	59	66.66	46.93	94.11	3	3	3	3	4	4	4	4	5	5	6	6	4	3	15	74	11	47	15	71	33.33	76.12	94.11
1	8.03	32	0	4	2	13	66	12	55	8	0	50.00	37.75	64.70	2	2	2	3	3	3	3	4	4	4	5	5	4	3	14	71	14	63	9	45	66.66	67.12	82.35
1	8.04	41	0	5	4	14	70	14	60	15	71	83.33	55.10	88.23	4	4	5	5	6	6	6	7	7	7	8	8	6	5	17	82	16	70	17	80	100.00	86.16	100.00
1	9.07	43	0	3	2	16	74	18	74	17	72	80.00	88.34	100.00	4	4	5	5	6	6	6	7	7	8	8	8	5	4	18	82	20	83	19	80	100.00	100.00	100.00
1	9.05	47	0	11	1	17	77	16	65	16	67	83.33	55.10	88.23	3	3	4	5	5	5	6	6	6	6	7	7	2	2	18	82	17	70	17	72	100.00	93.16	100.00
1	10.06	0	51	4	1	15	66	14	56	15	57	61.29	77.66	88.23	4	4	5	5	6	6	6	7	7	7	8	8	5	3	16	71	16	63	17	66	100.00	97.20	100.00
1	10.08	0	55	3	2	14	61	19	74	19	73	83.33	86.73	100.00	5	5	6	6	7	7	7	8	8	9	9	9	5	4	16	70	21	83	21	80	100.00	100.00	100.00
2	10.08	0	47	5	5	15	65	17	66	16	60	91.66	76.53	100.00	4	4	5	5	6	6	6	7	7	7	8	8	7	7	16	70	19	74	19	73	81.48	99.02	100.00
1	10.09	0	49	5	4	12	56	16	61	18	69	100.00	78.57	100.00	4	4	5	5	6	6	6	6	7	7	8	8	7	5	16	70	18	70	19	73	80.00	99.02	100.00
1	10.09	0	52	5	4	18	77	18	70	19	73	69.23	83.49	100.00	6	6	7	7	7	8	8	9	9	9	10	10	7	5	20	84	21	82	21	80	100.00	100.00	100.00
1	10.11	0	53	5	4	18	76	19	74	9	73	63.33	80.58	100.00	6	6	7	7	7	7	8	8	8	9	9	10	6	4	19	80	21	82	21	80	100.00	100.00	100.00
1	10.10	0	54	4	3	15	64	18	70	18	69	85.18	82.52	100.00	7	7	8	8	8	9	9	9	9	10	10	10	6	5	18	76	20	77	20	76	100.00	100.00	100.00
1	9.07	43	0	4	3	16	74	18	74	17	72	77.41	87.37	100.00	4	4	5	5	6	6	6	7	7	8	8	8	7	7	18	82	20	83	19	80	93.54	100.00	100.00
1	10.08	0	47	5	3	19	81	22	87	22	86	79.31	89.32	100.00	5	5	6	6	6	7	7	8	8	9	9	9	8	6	22	92	23	91	24	94	100.00	100.00	100.00

Contd.,

C_gender	C_age	DCD_8_9	DCD_10	C_copm_per	C_copm_sat	C_vmi_RS	C_vmi_SS	C_vp_RS	C_vp_SS	C_mc_RS	C_mc_SS	C_etch_WL	C_etch_LL	C_etch_NL	C_pqrs_wk_1	C_pqrs_wk_2	C_pqrs_wk_3	C_pqrs_wk_4	C_pqrs_wk_5	C_pqrs_wk_6	C_pqrs_wk_7	C_pqrs_wk_8	C_pqrs_wk_9	C_pqrs_w_10	C_pqrs_w_11	C_pqrs_w_12	Cp_copm_pr	Cp_copm_st	Cp_vmi_RS	Cp_vmi_SS	Cp_vp_RS	Cp_vp_SS	Cp_mc_RS	Cp_ms_ss	Cp_etch_WL	Cp_etch_LL	Cp_etch_NL
1	8.01	42	.00	2	2	7	0	9	0	9	0	66.66	48.97	70.58	2	2	2	2	2	3	3	3	3	3	4	4	2	3	8	45	8	45	9	0	100.00	55.10	88.23
1	8.04	47	.00	2	2	6	0	8	0	8	0	50.00	40.81	76.47	2	2	2	2	2	3	3	3	3	3	4	4	3	2	8	45	8	0	9	45	50.00	41.83	88.23
1	8.03	39	.00	1	1	6	0	8	0	8	0	50.00	39.79	70.58	1	1	1	1	1	2	2	2	2	2	3	3	1	1	8	45	8	0	8	0	50.00	41.83	88.23
1	8.04	40	.00	2	2	8	45	11	47	14	65	66.66	48.97	76.47	1	1	1	2	2	2	2	3	3	3	3	4	2	2	7	0	11	47	14	65	66.66	47.95	88.23
2	9.03	52	.00	4	5	16	75	17	71	16	70	83.33	92.23	100.00	4	4	4	4	4	5	5	5	5	5	6	6	5	5	17	78	18	75	17	75	90.00	97.08	100.00
1	9.08	50	.00	3	2	11	54	11	45	11	45	100.00	78.57	100.00	3	3	3	3	3	4	4	4	4	4	4	4	3	3	11	54	12	47	12	47	100.00	77.55	88.23
1	9.11	53	.00	2	2	12	57	17	69	16	65	91.66	78.57	100.00	2	2	2	2	3	3	3	3	3	3	3	4	2	2	13	61	18	73	16	65	83.33	74.48	88.23
1	10.02	0	55.00	3	3	13	59	17	68	12	47	91.66	73.46	100.00	2	2	2	2	2	3	3	3	3	3	3	4	3	3	14	63	16	63	12	47	91.66	77.55	94.11
1	10.03	0	53.00	3	2	15	67	10	0	13	52	100.00	76.53	100.00	1	1	1	1	2	2	2	2	2	3	3	3	3	3	14	63	11	45	13	52	100.00	77.55	94.11
1	10.03	0	50.00	2	2	13	59	13	51	10	0	83.33	72.44	100.00	2	2	2	2	3	3	3	3	3	3	3	4	2	2	13	59	13	51	10	0	100.00	80.61	94.11
2	9.04	0	46.00	3	4	15	70	12	48	17	72	81.48	82.52	100.00	4	4	4	4	5	5	5	5	5	5	5	5	4	5	16	74	13	54	18	76	81.48	87.37	100.00
1	10.06	0	46.00	4	3	15	66	13	50	17	66	75.00	72.44	82.35	2	2	2	2	2	3	3	3	3	3	3	3	4	4	16	71	13	50	18	70	83.33	79.59	100.00
1	10.08	0	51.00	4	3	15	65	17	66	18	69	73.52	83.65	100.00	2	2	2	3	3	3	3	3	3	3	3	4	5	3	16	70	17	66	19	73	100.00	86.53	100.00
1	10.09	0	50.00	4	3	15	65	17	66	17	65	83.33	72.44	100.00	1	1	1	1	2	2	2	2	2	2	3	3	4	4	15	65	17	66	19	73	91.66	82.65	100.00
1	10.10	0	49.00	3	2	16	69	16	61	16	60	75.00	72.44	94.11	2	2	2	2	2	2	3	3	3	3	3	4	3	2	16	69	16	61	16	60	91.66	79.59	94.11
1	8.04	40	.00	4	3	8	45	11	47	14	65	66.66	48.97	76.47	1	1	1	2	2	2	2	3	3	3	3	3	2	2	7	0	11	47	14	65	66.66	47.95	88.23
1	10.02	0	55.00	4	3	13	59	17	68	12	47	91.66	73.46	100.00	2	2	2	22	2	3	3	3	3	3	3	3	3	3	14	63	16	63	12	47	91.66	77.55	64.70